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The Plate Glass Casting Process According to Bicheroux

By Dr. A. Wendler

Translated by J. B. Krak, Technical Editor

WE are gratified to present to readers of The GLASS INDUSTRY the first authentic description to appear in print of the Bicheroux process of plate glass manufacture, written for this journal by one of the world's foremost experts on glass-making machinery, Dr. A. Wendler of Berlin, Germany. Dr. Wendler is the author of the chapter on "Machines for the Working of Glass," of the well-known standard treatise on glass technology, "Die Glasfabrikation," by Dralle-Keppeler.—EDITOR.

The origin of the art of changing blown glass sheets into mirrors by covering them with metal, is lost in the darkness of past centuries, but it can be proven by documentary evidence that this art was known in Germany as early as the year 1300. From there it was transplanted to Venice, where it developed to great perfection. In later years it spread to France and England.

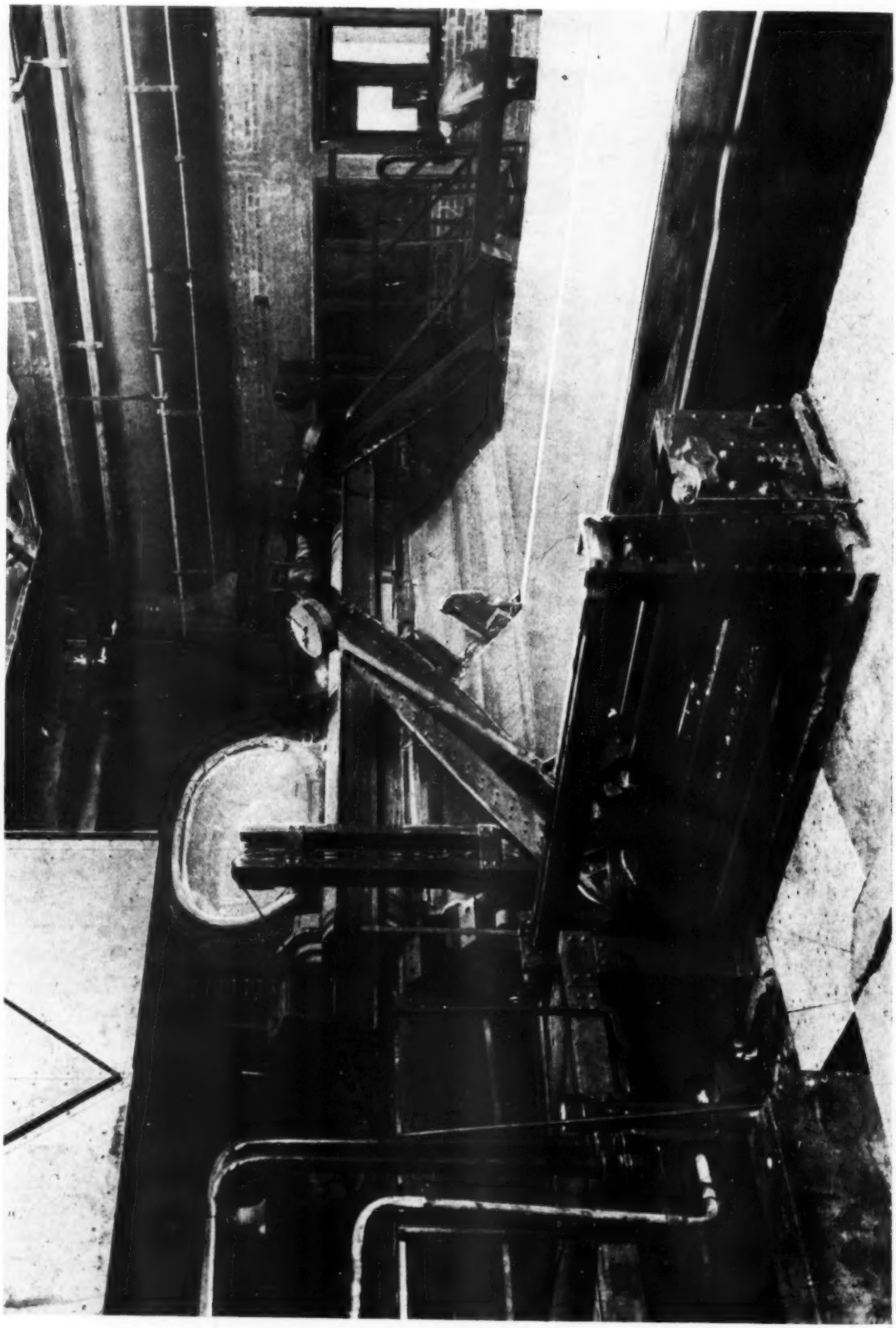
To Lucas de Nehou, manager of a French mirror glass factory producing blown sheet glass, belongs the credit of introducing the revolutionary change of casting plate glass. It was the conception of Nehou to cast the molten glass on a flat surface directly from the melting pot, and to flatten it by means of a roller which is maintained at an even distance from the casting table by metal strips, resulting in the formation of a plate of glass of uniform thickness. This process made it possible to manufacture very much larger plates than is feasible by the blowing method. From the beginning this new art was forced to produce plates of large sizes due to restrictions dating back to ancient trade privileges which prohibited the manufacture of mirrors smaller than 1½ x ¾ meters.

Simple and easy of operation as might seem the idea of Nehou, yet the execution held many difficulties. These troubles were first of all, the complete transparency of plate glass. The smallest defect which remains from the fining process, every cord, the smallest air bubble, and in addition the cords and seeds caused by rolling the glass into plates are retained. Not even the slightest defect can be hidden in this perfect transparency from the keen eye of the buyer. Everyone who goes through a plate glass factory marvels at the stringency of the inspection for defects which is exercised, and the high demands on the purity of the raw materials that must be satisfied by the inspection rules.

A second difficulty is the size and the weight of the product, which is vastly in excess of those with which other branches of the glass industry have to deal.

The full importance of these factors, the considerable weight of the glass mass which has to be handled at one time, will become evident on inspection of Fig. 1, showing the relation between the viscosity of molten glass and the temperature. The graph shows that the viscosity of glass during cooling varies very little until about 1,000 deg. C. is reached; from that point on, however, the increase is uncommonly rapid, until permanence of form is approximately reached between 600 and 700 degrees. For the work of shaping the glass in the desired form, a temperature interval of from 1,100 to 900 degrees is available. However, at that moment a distinctly critical period ensues in which the glass plate, having a thickness of only little more than a centimeter with a surface of many square meters, is subjected to a rapid loss of heat, especially on the side resting on the water-cooled casting table. This causes the formation of strains which threaten to demolish the plate of glass. It is therefore urgent that a crew of several men be trained to act together with an accuracy measurable in seconds, so that the heavy plate can be brought into the safe harbor of the lehr, neither too soon nor yet too late. The lack of such a numerous and well-trained crew has been the cause of failure of many attempts to carry out the invention of Nehou. Fig. 2, illustrating the casting and rolling of rough plate glass in a glass factory at the beginning of the 18th century, shows fourteen men employed to cast and roll the plate and

[1]The description of certain features of the Bicheroux process in the September issue of this journal was based on early patents which have been superseded by the improved equipment shown in the present article.



THE HEART OF THE BICHEROUX PROCESS
Showing Melting Pot Completely Drained and Plate Glass Emerging from the Rollers

to convey it to the lehr. The ancient author to whom we owe this picture has indicated the personnel with numbers, like the crew of a piece of artillery. And truly, the personnel employed in the casting of rough plate must act with equal speed, accuracy and assurance to that required in the operation of heavy artillery.

Fig. 3 shows how the size of the plates has increased in the course of years. The plates shown were exposition efforts at the times indicated; after some years, however, their production became a regular performance.

Although occasionally a width of five meters has been obtained, a plate of glass of 40 square meters and a melting pot containing 1,000 liters are the practical limits. Above these, the difficulties grow rapidly, especially since with the increase in surface there is a corresponding thickness to be rolled, and an increase in the grinding and polishing. In order to save glass and the work of grinding and polishing, the thickness should be kept as small as possible. However, it is easy to see that the making of a plate of glass, free from defects, and its timely transfer to the lehr becomes more hazardous the thinner the glass is. Practical experience has

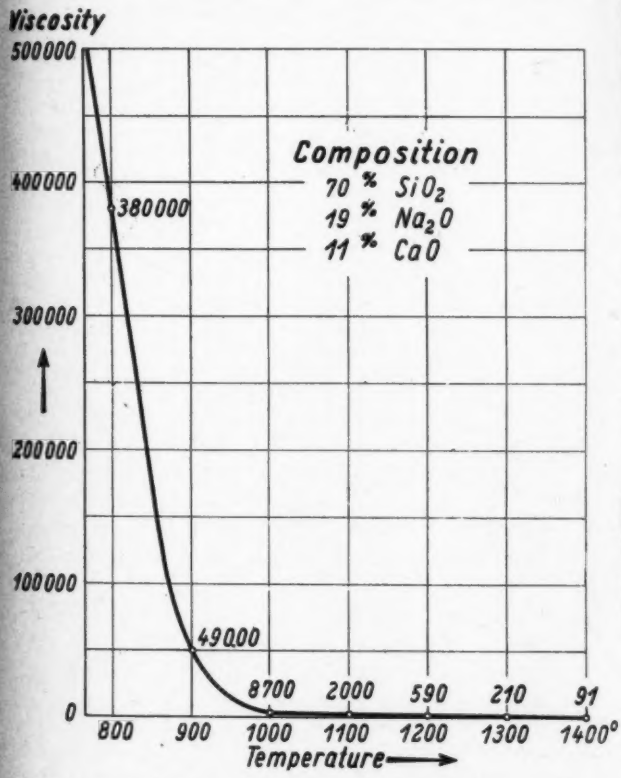


FIG. 1. DECREASE IN VISCOSITY OF WINDOW GLASS WITH INCREASE OF TEMPERATURE

proven that a glass thickness of about 11½ millimeters is the minimum that can be used to good purpose. A rough glass plate of this thickness must be made also when the finished, polished plate is desired to be only 6½ millimeters in size. In order to make such a plate of glass it is therefore necessary to remove more by grinding and to work at higher expense than in the case of thicker plate glass. We have then the paradox that thin plate glass is more costly than heavier plate. The primary object of Bicheroux's invention was to supply the great demand for thin plate glass. However, it has gained a far greater significance for the whole field of plate glass manufacture.

The first solution of the problem, found by Bicheroux, to make the thinnest possible rough plate by means of rolling, was based on the idea of cutting the band of glass of about 20 meters long in shorter sections, while it was being formed, and while still in a plastic condition, and to convey these parts at once to the lehr. The necessary apparatus for this purpose is shown in Fig. 4. The rapid cutting of the glass

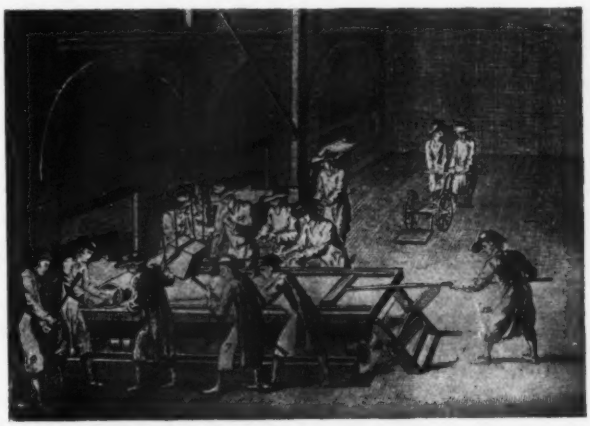


FIG. 2. CASTING AND ROLLING PLATE GLASS—18TH CENTURY

plates involved great difficulties, which were not overcome until after much experimenting. It was necessary to load down the rollers very heavily, in order to obtain a sufficiently thin layer of glass, which, due to its size cooled very rapidly. The first two or three meters, until the roller had become warm, could not be obtained thinner than 8¼ millimeters, even with a load of 30 tons. Although the process satis-

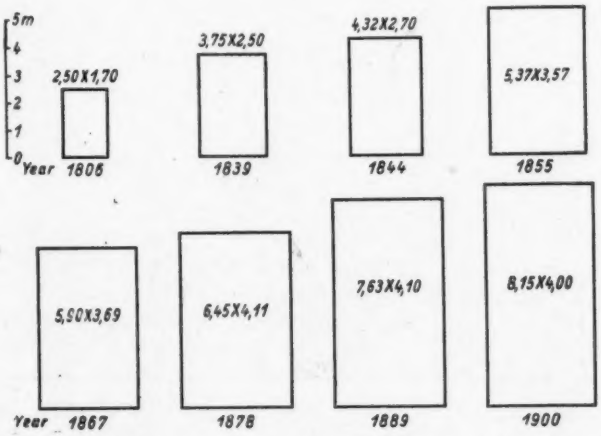


FIG. 3. INCREASE IN SIZES OF ROUGH PLATE. FROM 1806–1900

fied the expectations in general, it did not completely suit the inventor, so that after the interruption due to the war the work was again taken in hand, and on a broader basis than before.

If Fig. 2 is compared with Fig. 5 it is apparent how little the method of making plate glass has changed since the time of Nehou. It is true that from the small casting table of Nehou one of about 40 square meters has been developed, and that the modest melting pot has grown into one of about 1,000 liters in content. But still, like 250 years ago, the roller moves over the casting table. The fact is that it was

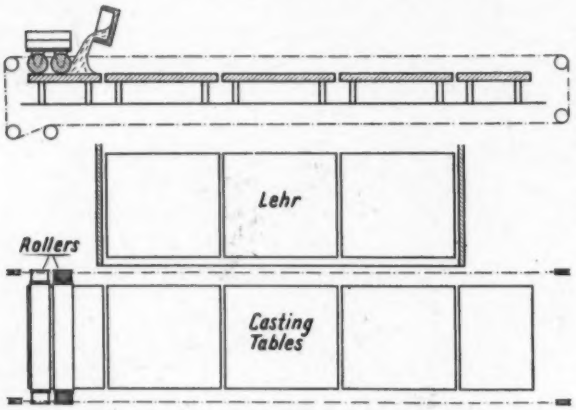


FIG. 4. FIRST BICHEROUX PROCESS
Outline

not considered possible to master in any other way the difficulties due to the properties of the materials, the size of the product and the high requirements as to quality. Experiments to change the method were discouraged on account of the size and cost of the apparatus, which in the course of years had grown to gigantic proportions.

It was therefore necessary to demolish a technical conception grown venerable through age. This required an exceptional amount of independence and daring of thought, since technical views and experiences, in the course of time, while they become more and more deeply imbedded in the human mind, are likely to become a kind of creed.

FIG. 5. MODERN PLATE GLASS PRACTICE

Chance had shown that under certain conditions it was possible to get along without traveling rollers, the source of so much trouble, by pouring the molten mass of glass on an inclined surface. This was located next to the opening between two superimposed rollers. However, the container used to pour the glass in this case was a ladle, with which the glass was taken from the furnace. And the products were plates of glass whose inner defects, namely air bubbles, were masked by means of a relief design, pressed in the surface of the glass. These plates were about 4 square meters in size. To imagine the hopelessness of the procedure to produce in this manner rough plate glass of sufficient quality for grinding and polishing, it is sufficient to consider that the pot contains 600 to 700 liters molten glass, which has to be poured in the many cornered space between the inclined pouring table and the pair of rollers. To pronounce an "Even So," under these conditions, to formulate the problem of rolling out the content of a normally sized pot in a rolling mill, to produce a perfect plate of rough glass of a size hitherto unobtained, to attack this problem and solve it was the original and daring accomplishment achieved by Bicheroux in his second attempt. It should be considered

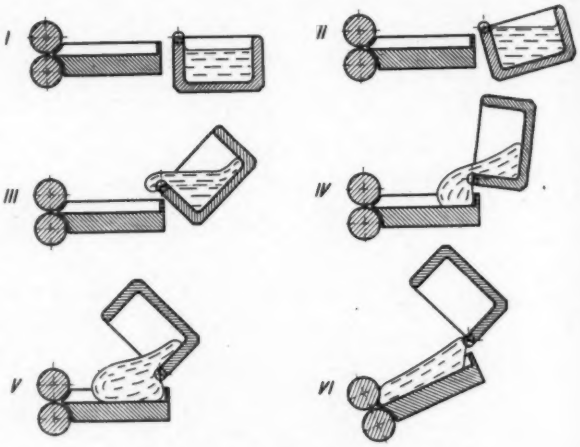


FIG. 6. SECOND BICHEROUX PROCESS
Outline

that in rolling a plate of glass of 6½ millimeters in thickness, a surface of about 80 square meters is obtained—about double the former maximum—in the same number of minutes as heretofore, and that this plate has to be conveyed to safety in the lehr.

Fig. 6 shows the solution of the problem, in a series of six drawings. A horizontal or moderately inclined casting table is located before the rollers. The table is of such a size that the content of the pot can be poured out thereon without lapping over and without the inclusion of air, so that it spreads over the surface with an even and unretarded motion, similar to that obtained by the usual casting process. After the end of the pouring, in position VI of Fig. 6, the part consisting of the casting table and the rollers is slowly tipped over, along the axis of the lower roller. In this way the glass is fed to the rollers. During the pouring of the glass on the casting table a special difficulty ensued. If the pot is tipped over along an axis slightly above the middle of the bottom, as is usual with the existing cranes, the edge of the pot is in a position considerably above the casting table. The distance through which the glass has to fall down is a source of considerable trouble which can only be avoided by the greatest care and much experience. This danger is even greater if the glass is poured on a limited area, such as is necessary in the Bicheroux process. It is therefore a great

improvement and a very favorable solution of the difficulty, to change the casting in such a way that the pot is tipped along an axis situated near the upper edge, as shown in Fig. 6. This arrangement materially decreases the height through which the glass has to fall and the outpouring of the glass becomes quite free from sudden movements. Overlapping and inclusion of air bubbles, as well as the folding of the surface, with formation of viscous glass parts is avoided in this manner, also the formation of surface defects due to dust and sand. During the tipping over, as shown in positions II to V of Fig. 6, the pot is elevated evenly and moved along the edge of the casting table. It is not necessary, however, to move the pot sideways and parallel to the rollers, as is customary during the work incident to the old plate glass process. The glass mass flattens out sufficiently without such movement of the pot on the receiver. This side movement in the usual plate glass process is often the cause of formation of surface masses that fail to dissolve completely during rolling, and remain as visible surface defects. This danger is obviated. It is not necessary to wait with the tipping of the casting table until the pot is completely emptied. If the rolling has already started, the advantage is gained of being able to decrease the size of the casting table, and therewith the amount of surface which absorbs the heat of the glass.

The following illustrations show in four positions the casting and rolling process. Fig. 7, position I, shows how the crane holds the pot with its upper edge at the edge of the receiver, and how it can be tipped over its upper edge, due to which the wave of molten glass is decreased in size. The glass flows therefore with a very small drop, more flowing than falling, before the rollers (Fig. 7). This is of the

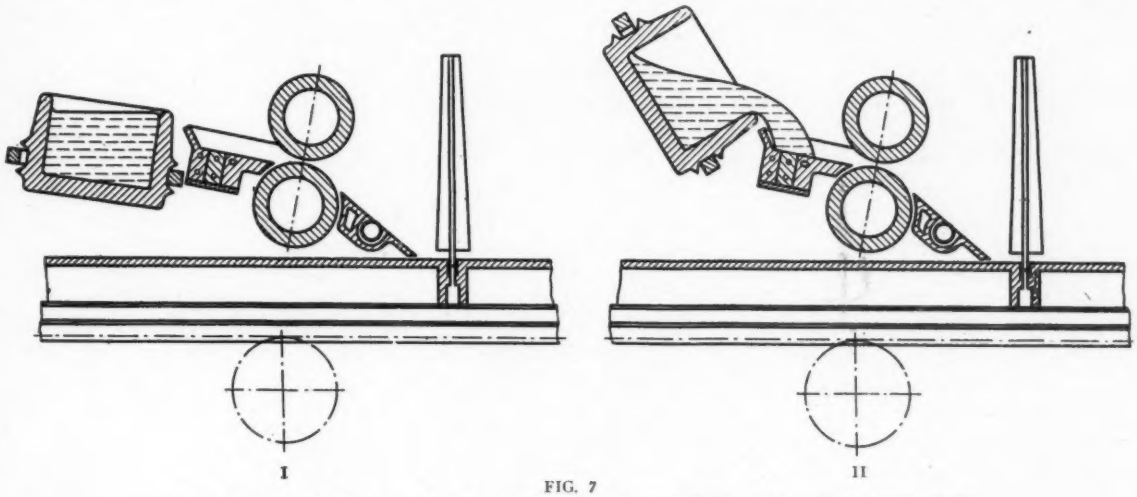


FIG. 7
PLATE GLASS ROLLING MILL OF BICHEROUX. BEGINNING OF CASTING OPERATION

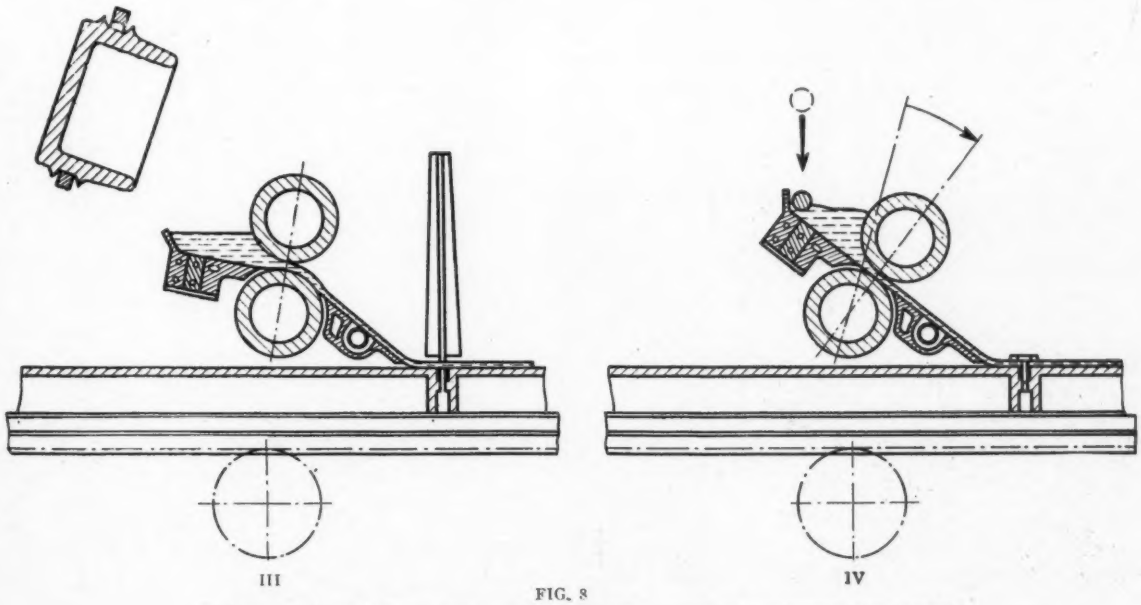


FIG. 8
PLATE GLASS ROLLING MILL OF BICHEROUX. END OF CASTING OPERATION

greatest importance for the maintenance of the homogeneity of the mass.

In the subsequent positions, Fig. 8, the mass of molten glass is carefully elevated by tipping of the receiver, so that the glass flows between the rollers. The rolled-out plate then moves over the inclined surface to the conveying tables, three in number, which move along under the rolling mill with a speed equal to the rotary velocity of the rollers. As in

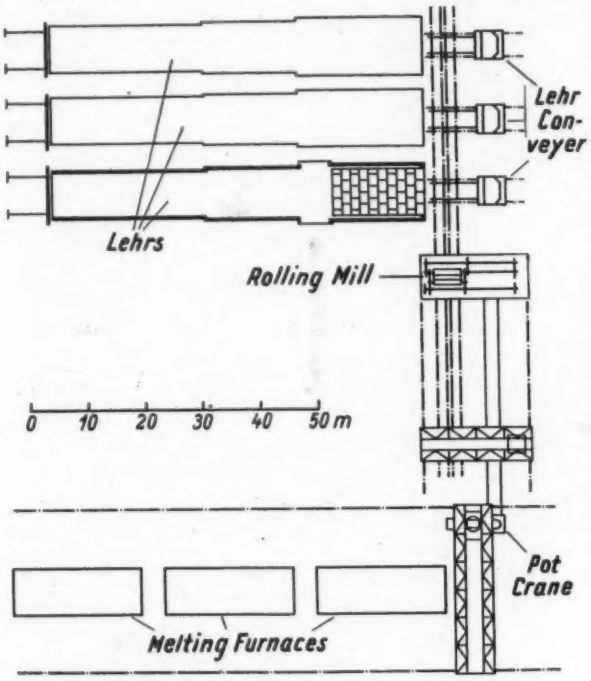


FIG. 9. PLATE GLASS INSTALLATION OF BICHEROUX
Layout of Plant

the first Bicheroux process, the cutting edge, situated directly after the rollers in an upright position, is let down every time an open space between two moving conveying tables reaches

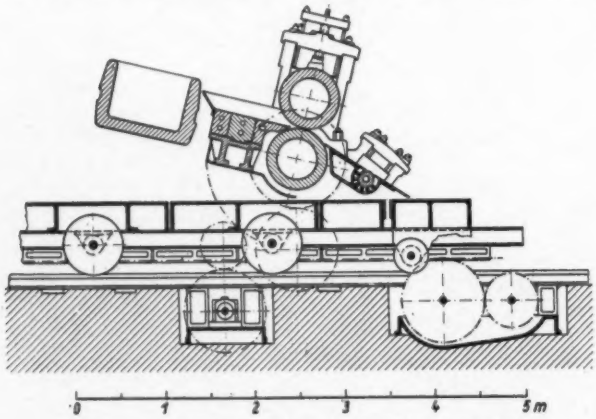


FIG. 10. ROLLING MILL OF BICHEROUX PROCESS
Section Through Rollers

it. During the time needed for cutting, the knife moves along with the conveyor. After being lifted to its upright position, it automatically goes back to its original stage.

In order to decrease further the width of the glass plates, when the thinnest kind of plate is being made, the installation at the Bicheroux works at Herzogenrath (illustrated on page 232), has a further improvement in the form of a wedge shaped "nose" located in front of the rollers, in the middle. This wedge divides the stream of molten glass into two parallel running bands, which are cut subsequently into six pieces by the knife. The installation of the "nose" is only required in the manufacture of the thinnest plates, to obtain a smaller sized product, since larger plates of such a small diameter might pile on top of one another during the movement through the lehr.

Fig. 9 shows an outline of a complete installation, for the manufacture of thin rough plate glass, of from 6 to 8 millimeters in thickness, using pots containing about 850 liters. At the bottom of the drawing is the pot furnace, at the bottom to the right is the mechanical conveyor for the pots and near it is located the crane, used to tip the pot. The crane takes the pot from the conveyor and moves it to the rolling mill. In the same line are the rails of the three transportation tables, or rather pairs of transportation tables, which carry the six plates of glass to three adjacent lehrs.

Figs. 10 and 11 show the rolling mill and the water-cooling system of the rollers and the casting table. The bearings of the rollers and the casting table form one solid piece, that can be tipped along the axis of the lower roller, so that during this movement the correct alignment of the casting table and the inclined surface leading to the transportation tables is maintained. The latter surface has a

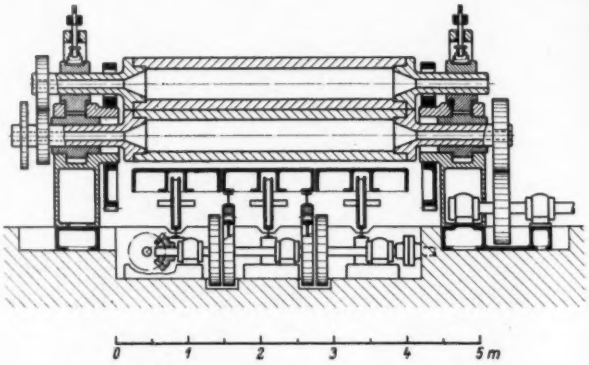
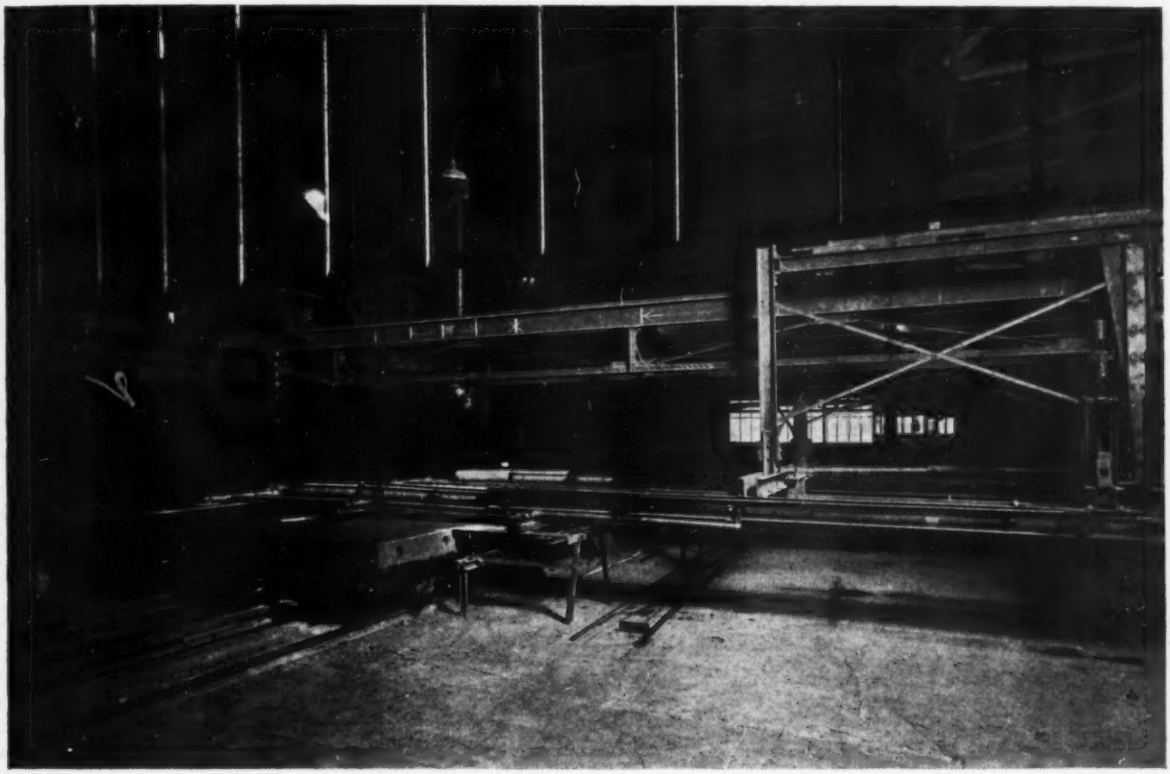


FIG. 11. ROLLING MILL OF BICHEROUX PROCESS
Section Through Rollers

roller acting as a brake for the descending plate of glass. Under the rollers are the transportation tables. The machinery for the combined moving of the rollers and the tables is shown also.

Fig. 12 shows the knives for dividing of the glass band. They remain in an elevated position as long as they are carried by means of a supporting bar on a flange of the table. They come down as soon as the 5 centimeter wide space between the two tables is reached, since at that place the supporting flange is omitted. At the same time the knives are carried along with the tables. The rollers have a length of 4.2 meters, which equals the width of the transportation tables, upon which the band of glass, about 4 meters in width is deposited. The photograph reproduced on page 232 shows the movement of the rollers, with the pot in tipped-

over position; the elevated knives, the band of glass coming from the rollers, cut by means of the wedge in two parts of equal width. The three transportation tables which follow one another have each a length of 6½ meters, so that the whole band of glass rolled out in one operation



APPARATUS TO CONVEY ROUGH PLATE FROM TRANSPORTATION TABLES INTO LEHRS

has a length of 19½ meters and a width of twice 2 meters, forming six plates of glass of 2 x 6½ meters. As soon as one of the transportation tables is fully covered with glass, and after the glass band has been cut, the table is taken off the conveying train and is moved by a separate machine to the lehrs with increased speed. All movements of rolling, cutting, and transportation of the plate to the lehr are fully automatic. In front of the lehrs is located the machinery needed to push the plate into the lehr. This consists of two parallel bridges (see above) which push two adjacent plates of glass in the lehr at the same moment.

The technical and economic advance which this new process signifies is one of great importance. In the first place one obtains with the same quantity of molten glass almost double the number of square meters of rough plate of 6½ millimeters thickness, suitable to produce plate glass from 4 to 5 millimeters thick. Whereas with the old process the production of rough plate glass from a pot containing about 850 liters amounts to about 31½ square meters (figuring 10 per cent loss in the lehr and after deduction of the cutting loss), there is an output of about 60 square meters from the same size pot when the Bicheroux process is used, allowing a loss in the lehr of twelve per cent. The production is therefore almost double. This amazing result is due primarily to the fact that in the new process the glass can be rolled thinner, on account of the use of two rollers. Since the plates can be rolled thinner, there is less glass to be ground off, and this again is possible due to the fact that the variation in thickness of the glass is much less than is the case when the glass is cast and rolled on an ordinary table.

The advantage of regularity of the glass thickness is gained through the fact that it is much easier to maintain

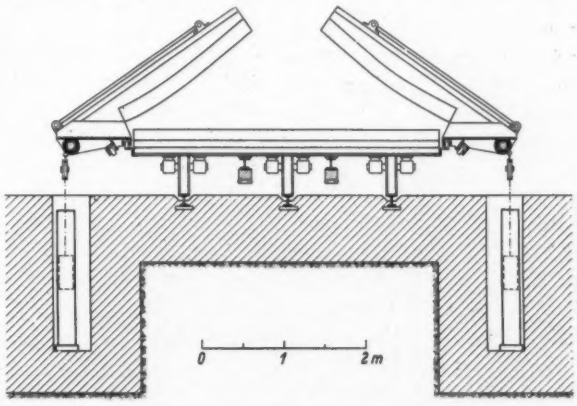


FIG. 12. PLATE GLASS ROLLING MILL OF BICHEROUX PROCESS
Arrangement of Cutting Knives

the cylindrical shape of two rollers, in spite of the heating caused by the glass, than to keep the casting table, used in the old process, always rigidly horizontal, even with the

best cooling system. In the old process the roller always becomes slightly curved, since the side which touches the molten glass at the moment of pouring becomes more expanded. It is true that in the Bicheroux process also the sides of the rollers first exposed to the glass become the most expanded, however, the curvatures of the rollers can be greatly decreased by allowing the rollers to run during the pouring of the molten glass on the casting table, whereby the whole surface becomes evenly heated. While the variation in thickness in the old process, producing glass of 11½ millimeters, averages from 2½ to 3 millimeters, it does not surpass 0.6 millimeters in the Bicheroux process. To obviate differences in thickness, it is necessary to remove only 2 millimeters of glass instead of 4½ millimeters. The fluted surface,[1] which occurs on the rollers and on the tables also tends to increase production. The surface defects which always occur in the old process are in this way completely eliminated, coldcracks are also absent. The output of rough plate per pot is greater than the decrease in thickness of the glass, since as a result of fewer glass defects there is less loss. Freedom from defects is caused, among other reaons, by the fact that during the casting of the glass it is not necessary to move the pot sideways, as is necessary in the table process. The surface folds caused thereby are obviated. The peculiar tipping motion allows the pouring of the glass to proceed in six seconds, against 1½ seconds in the table process. The glass flows much more quietly, and acquires a smooth surface. The gain obtained by this method of pouring due to greater purity and freedom from defects is shown by the fact that from a pot containing about 650 liters of molten glass, there is formed 390 liters, or 58 per cent finished rough glass, against 44 per cent with the table process. Greater freedom from defects causes more glass to be produced of first grade quality. The savings during the grinding and polishing are also considerable. In spite of the greater surface to be ground per pot, the actual grinding is not increased, since only about half the amount of glass has to be removed by the grinding process.

These factors all cause not only a decrease in wages, power and materials, but also a greater efficiency of the grinding machinery, due to shortening of the time necessary for grinding. The increase in efficiency is estimated to be about 35 per cent. Even when not the thinnest plate glass, but glass of 7 millimeters is produced, there is an advantage of 38 per cent, since in the Bicheroux process the rough plate needs to be only 9½ millimeters thick, whereas in the table process it is 11½ millimeters. The means, for instance, for a factory with two furnaces, which must increase production, that the introduction of the Bicheroux process saves the installation of a third furnace.

The process and the machinery, which are protected by a large number of patents, have aroused a great deal of interest in the glass industry, proportionate to the extraordinary advantages which it offers. In continental Europe, and especially in America several installations of this process are being made. The Edward Ford Plate Glass Company in Rossford, Ohio, is, we believe, the first factory in the United States to obtain a license to practice the process and are preparing to put it into operation.

As the firms which have taken up the new process already produce one-quarter of the world's production of plate glass, it will be realized that the Bicheroux process will play an important part in the further development of this industry. The peculiar advantages of the Bicheroux process make it well able to compete with other new methods of plate glass production, for instance the American process by which the glass flows directly from the tank into the rolling mill, and is rolled into an endless sheet. Only one of these attempts, that of the Ford Motor Company,[2] has led to an industrial success, but it yields only plate glass of about one meter in width, for automobiles. To make wider plate glass for general purposes by a continuous process has not been successful, and experiments carried out with this purpose, and at great expense, have proved to be failures, as has been reported during the hearing of experts at the inquiry on plate glass production cost of the United States Tariff Commission.

[2] The Pittsburgh Plate Glass Company also is producing windshield glass by a continuous process, which is understood to be very successful.—EDITOR.

Gaseous Fuels for Furnace Heating*

The chief gaseous fuel is producer gas, made by the partial combustion of coal (or coke) in an air-steam blast. Considerable variation in composition may be obtained by modifying the ratio of air to steam. Increasing the steam causes the partial replacement of carbon monoxide by hydrogen, and of nitrogen by carbon dioxide. A moderate use of steam improves the gas, but a further increase is disadvantageous. In a bunsen flame, the flame speed determines the back-firing tendency, and the height of the inner cone. Hydrogen will thus give a shorter flame than carbon monoxide or methane.

In a non-aerated jet flame, on the other hand, the flame length depends chiefly on the air requirement. Hydrogen and carbon monoxide, each needing 2½ times their own volume of air, will give equal jet flames, while methane, needing 10 volumes of air, will have a flame 4 times as long as either. Reduction of the oxygen in the atmosphere will cause a lengthening of the flame, which will finally leave the burner top and float about just before extinction.

The flame in a furnace may be regarded as jet flame modified by turbulence to something approaching a bunsen flame. Hydrogen will still give a shorter flame than carbon monoxide in such circumstances. A long flame is generally preferred, to give uniform heating.

Hydrogen more than other gases is liable to undergo flameless catalytic "surface combustion" in contact with red hot brickwork. This (in ordinary furnace) is undesirable.

Gas rich in carbon monoxide is to be preferred on account of its longer flame, greater radiating power, and smaller liability to surface combustion. Uniformity in the gas (or at all events, absence of accidental variations) is obviously also very desirable, apart from the actual composition. These ends can only be secured by proper control over the blast saturation temperature of the producer; a thermometer in the blast pipe, or some more elaborate equivalent, is essential. Some form of positive blower is much easier to control than the usual steam jet.

*Review of a paper presented by R. Wiggington at a meeting of the Society of Glass Technology at Sheffield, England.

Regeneration in Glass-Tank-Furnaces

By S. R. Scholes*

In a regenerative furnace, the flame-gases are conducted out of the furnace through chambers filled with a checker-work of refractory brick. By a set of reversing valves, the direction of the movement of air and fuel is reversed at regular intervals, so that the incoming air—and also the incoming fuel, when producer gas is used—passes through this hot checker-work and is pre-heated. Another set of checker-chambers on the opposite side of the furnace now receives heat from the used fire-gases.

By this means a large proportion of the heat which would otherwise be carried out of the stack in the flue-gases and lost is returned to the furnace. An important result of regeneration is the attainment of a much higher flame-temperature than would be possible without pre-heating. The return of heat is important primarily as a measure of economy, but is also a means of securing the high flame temperature requisite for the heating of the furnace.

In the glass industry, small furnaces for the melting operation, such as pot furnaces and day tanks, are sometimes built to operate without pre-heating of air or fuel. When natural gas or oil is burned, a satisfactory temperature can be maintained; with producer gas, this is not feasible, because the flame temperature of producer gas burning with cold air is too low. Moreover, such furnaces show a greatly increased fuel consumption over regenerative furnaces of similar size.

Heat Transfer Worthy of Study

Heat transfer in checker-chambers, or regenerators, is a subject worthy of more detailed study than has hitherto been accorded to it. Much has been taken for granted, and left to the empirical rules of furnace builders. These rules are based on experience, to be sure, but experience and experiment differ in thoroughness and in the accuracy of the data obtained. It might be of interest to consider the mechanism of the storage of heat by checker-brick and its absorption by the incoming air.

When the spent flame-gases leave the furnace, at a temperature usually well above 2,600°F., they pass out through the ports, down uptakes of greater or less length, and impinge upon the upper courses of checker-brick. The surfaces of these brick become heated almost at once. To be sure, in a properly operated furnace, these brick at the time of reversal are still at a bright red heat. The heat now travels toward the interior of each brick, at a rate depending upon the conductivity of the refractory and its specific heat, or capacity for heat. Of these properties, more will be said later.

As the gases pass down through the chamber, they lose heat steadily, leaving behind them hotter and hotter brick, and meeting cooler ones as they go. At the base of the checker-chamber, the gases pass into a flue leading to the stack. They still retain a great deal of heat, however, as evidenced by the fact that stack gases from a glass tank-furnace are often at a temperature of 1,000°F., or higher.

It is obvious that the checker-brick must be a little cooler, at least, than the flue-gases which have just passed them. This refers to their surfaces. The interiors of these brick may be many degrees cooler than their surfaces. This matter of the soaking in of heat depends primarily on the two physical properties of conductivity and specific heat, and here the thickness of the brick enters into the estimation, as well.

During this passage of the flue-gases down through a checker-chamber, the walls of the chamber and of the flue leading to the stack are necessarily heated also, and play some part in the return of heat to the furnace during the second half of the regenerative cycle.

The valves are now reversed, and outside air enters the air-valve, passing in through the hot flue and up through the regenerator. Conditions are now opposite. Heat is flowing from the brick to the air, which becomes more and more heated as it rises, until it enters the furnace at a temperature something less than that of the upper portion of the regenerator. The same properties of the refractory, and its thickness, govern this transfer, as mentioned above.

Construction of Checker-Chambers

The usual checker-chamber is a brick-walled room running the length of the melting-chamber of the tank, 4 to 7 feet in width, and 7 to 8 feet high. It is floored with "rider-arches," which form the covering for a flue-space as long and wide as the chamber. In it are stacked fire-brick in one of several conventional arrangements. Usually the brick are standard 9-inch size, set on edge in such a way as to leave vertical passages 4 to 6 inches wide between bricks. It is not considered good practice to stagger the courses of brick, because of the consequent accumulation of clogging dust. Often the choice of brick-spacing is different as between gas and air regenerators, because of the greater need for pre-heating the air. Accordingly, the gas regenerator is usually smaller, and may have wider spacing of courses, requiring fewer brick.

Perhaps the most usual defect in checker-chamber construction is lack of sufficient volume, so that not enough checkers can be laid to provide ample heat storage, nor is the space generous enough to provide free draft up and down after a few months' service has clogged the passages with batch-dust. There is no doubt that regenerators can be too large, and thus fail to become hot enough to be effective, but such a condition seems to be rare.

From the nature of its duties, the qualifications of a good checker brick or tile seem to be clear: high conductivity, high specific heat, and high specific gravity—both apparent and real. High conductivity for heat insures the prompt absorption and emission of heat; high specific heat means larger quantity of heat stored per pound of refractory; while high specific gravity allows for more pounds of heat-storing material per cubic foot of space occupied.

The refractory best answering these specifications, so far

* Federal Glass Company, Columbus, Ohio.

as glass tanks are concerned, is, in the writer's opinion, a clay brick or tile of dense structure, hard burned, weighing about 7½ pounds for the standard 9-inch size. One still hears occasionally of a preference for porous fire-brick for checkers, the idea being that heat soaks into brick somewhat as water would. A simple experiment in heat transfer, such as applying heat beneath such a brick and a can of water on top of it, at the same time doing similarly with a dense brick, will convince the user of porous checker brick that they are too good as insulators to be considered for regenerators.

It is not a simple undertaking to measure the temperature of checker-brick in service, or that of the air rising through the chamber. Some interesting data may be obtained by placing a thermocouple in the flue near the air-valve. Here there is less error due to radiation from the walls and checker-brick, and a fair idea of the rise in temperature of the outgoing gases may be obtained. This is an indication of the heating going on in the base of the checkers. It will probably be found that in 20 minutes after reversal, the outgoing flue gases have practically reached a maximum temperature. Also, it will be noted, the regenerative effect of the hot valve, and flue, are important.

Since 600°F. is regarded as probably the best stack temperature, for maximum draft consistent with volume of gases to be moved, the function of checkers should be to abstract heat from the flue-gases down to this temperature. Therefore, a flue-temperature above 600°F. is an indication that the checkers are inadequate.

The Regenerator of the Future

The ideal regenerator would be one so designed and filled as to carry the flue-gases through without obstruction and pass them on to the stack at 600°F., or less. It would at the same time become so highly heated at the top as to give the incoming air a temperature of 2,200°F., or over. The approach to this ideal will undoubtedly require a design in regenerators higher and perhaps narrower than most of those in use. The first requirement, cooling the gases, is easily satisfied by a large chamber, of whatever shape, well filled with brick or tile. But if the absorption of heat takes place over too large a cross-section, the maximum temperature of the checkers will not be sufficiently high.

Furnace builders are acquiring much valuable experience along these lines, but the replacement of regenerators is an operation requiring large outlay. It would be much better if an approximately correct regenerator design could be reached by calculation from reliable data.

Here, however, is a lack. We need to know: the heat-conductivity of fire-clay over a wide temperature range; the actual rate of temperature rise in a piece of refractory of given dimensions, at certain initial temperatures, and exposed to gases at certain temperatures; and whether or not the rate of heat emission is the same as that of absorption.

When these and a few other bits of data not now accurately known are available, it should be possible to build regenerative furnaces much more economical than those we now have.

Bureau of Standards Circular on Ultraviolet Glass

The Ultraviolet Spectral Transmission of Various New Glasses and Window Glass Substitutes, Used in Therapy

Letter Circular LC 235 (revised). Prepared by W. W. Coblentz. Issued September 14, 1927.

1. This letter circular is issued in response to numerous inquiries for information on the transmissve properties of new glass and organic substitutes for window glass for use in solariums, sun parlors, animal houses, etc.

2. The data presented in paragraph 4 refer to the extreme ultraviolet region of the solar spectrum, which rays of wave-lengths less than 3100A are *almost completely absorbed* by common window glass and which are found to have a therapeutic value in preventing rickets, etc.

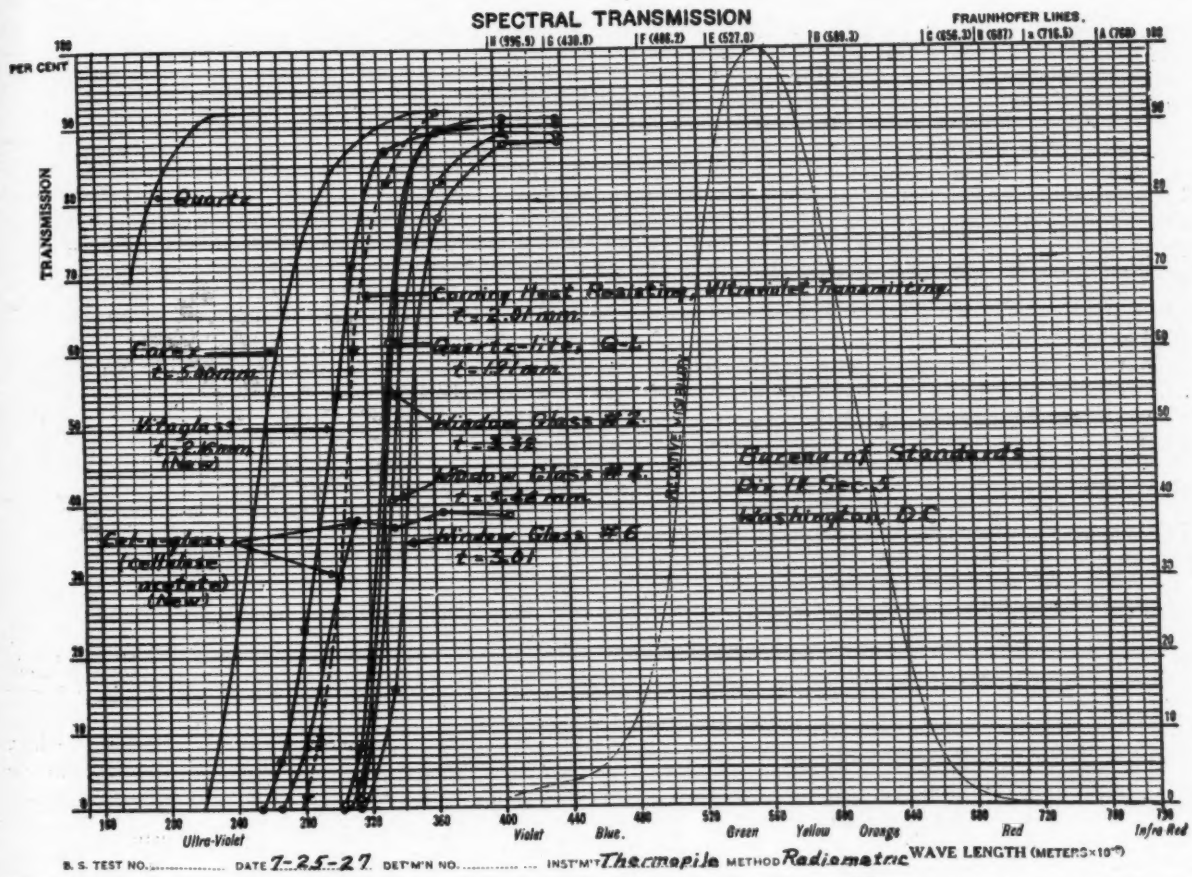
The data presented in paragraph 5 refer to the long wavelength (3100 to 4000A) ultraviolet solar rays *largely* transmitted by common window glass, which information is sometimes requested in connection with the general problem of light stimulation. It is not the function of this Bureau to pass judgment on these claims and reference is made to recent biological tests of substitutes for window glass described in the *Journal of the American Medical Association*, Vol. 88, p. 1562; May 14, 1927.

3. Biologically, it is found that ordinary window glass completely absorbs the short wavelength (less than about 3100 A. U.)[1] ultraviolet rays of the sun which have a therapeutic value in preventing rickets, etc. Recently new glasses, and organic substitutes for window glass, have been developed which transmit some of these therapeutic rays.

Using a common window glass as a filter, having a transmission = 0 per cent for wavelengths less than 3100A, radiometric measurements were made at sea level, during the noon hours in April, May and June, 1927, to determine the magnitude of this short wavelength ultraviolet radiation in terms of the total incoming solar radiation. This gives at the noon hour about 3.5 to 4 per cent of the total (which varies from 1.25 to 1.3 gr. cal. per cm^2 per min.) or 0.04 to 0.05 gr. cal. per cm^2 per min. The value is fairly constant for 3 to 4 hours, during midday, but decreases to an imperceptible value at sunrise and sunset. It fluctuates greatly with weather conditions and the season, falling relatively low in the winter and rising to its maximum value when the solar altitude is highest.

4. ULTRAVIOLET ABSORBED BY WINDOW GLASS.—By direct radio metric measurements made during the noon hours in April to June, 1927, the total amount of these short wavelength ultraviolet solar rays of wavelengths less than 3100A transmitted by these materials, when new, was found to be approximately:

[1] Angstrom Units.



Quartzglass and Corex	92 per cent
Vitaglass	50 per cent
Celoglass	20 per cent
Quartz-Lite	5 per cent
Flexoglass	1 per cent
Window glass	0 to 5 per cent

5. ULTRAVIOLET TRANSMITTED BY WINDOW GLASS.—The data tabulated in paragraph 4 relate to the ultraviolet solar rays of wavelengths less than 3100A which are largely *shut out* by average window glass, and which are known to have special therapeutic properties.

On the other hand, considering the long wavelength ultraviolet rays extending from 3100 to 4000A, which are *transmitted* by window glass, but which are not considered as having special health-giving properties, the transmissions are as follow::

Quartzglass and Corex	92 per cent
Vitaglass	88 per cent
Quartz-Lite	85 per cent
Window glass	83 to 85 per cent

6. The ultraviolet spectral transmissions given in the attached graph were determined by using monochromatic light from a quartz mercury arc lamp. The same transmission curves would have been obtained by using monochromatic light from any other source.

The samples of window glass used in these tests came from the supply in this Bureau's carpenter shop. They had closely the same thickness (3mm) and were selected to show that the most greenish tinted samples absorb the greatest amount of ultraviolet radiation.

From a comparison of the spectral transmission curves, an estimate can be formed regarding the therapeutic value of the various glasses.

7. The infrared spectral transmissions of the various glasses are closely the same as that of window glass to 3μ beyond which wavelength the question of transparency is unimportant, since the atmosphere absorbs the solar rays of greater wavelength.

8. Attention is to be directed to the fact that in some of these glasses the high transparency to the extreme ultraviolet rays is obtained partly by reducing the thickness. Hence, in installing such glass, attention should be given to the use of sash of proper size to meet safety requirements.

Reducing Fuel Costs in Refractory Plants

Substantial economies in the operation of plants manufacturing refractories, with improvement in the quality of the wares produced, were effected as the result of a series of firing tests conducted by engineers of the United States Bureau of Mines, Department of Commerce, at seven large establishments of this character. The plants visited by the Bureau of Mines engineers included magnesite-brick, silica-brick, and fireclay-brick plants located in various eastern States. The specially equipped laboratory car "Holmes" was used in the investigation. Changes made by the engineers in the operation of the kilns resulted in reducing the time of burning and the clay consumption at most of the plants visited, and in some cases resulted in a better burning which gave a large percentage of first-quality brick.

The History of the Incandescent Lamp

(Concluded from the September issue)

Mitchell and White Tipless Construction

L. E. Mitchell and A. J. White, of the General Electric Company, invented a method of tubulating the stem seal which made a great improvement in lamp construction. Their method eliminated tubulating as a separate operation, thus reducing the cost of lamp making and eliminating the exposed tip on the lamp. All lamps for standard lighting service are now so made.

In this method the exhaust tube is placed inside the stem tube in the stem-making machine. The inner ends of the two tubes are sealed together, closing both tubes, making a mass of glass in which the leading-in wires are imbedded. While this mass of glass is still soft, air is blown in the outside end of the exhaust tube, the air pressure blowing a hole through the soft glass at this soft mass. Through this hole the exhaust tube communicates with the inside of the bulb.

Thus the tubulation of the lamp is done on the stem making machine. When the lamp has been exhausted and, in the case of gas-filled lamps, the gas has been allowed

MITCHELL & WHITE TIPLESS CONSTRUCTION

The exhaust tube is put inside the stem tube with the leading-in wires, the end fused and pinched together. While the seal is still soft, air is blown through the exhaust tube making an opening at the seal. All standard lamps are now made this way.

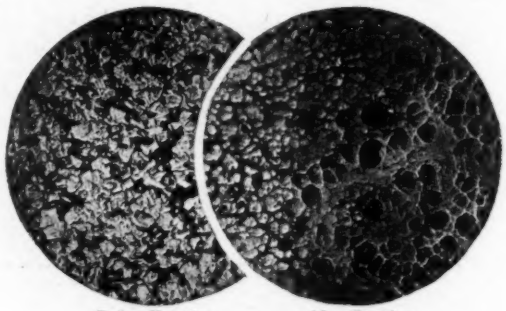
to flow in, the exhaust tube is sealed off close to the lamp so that the tip is completely concealed by the base.

Frosting

The light from a clear bulb incandescent lamp is exceedingly dazzling on account of the high brilliancy of the filament. In a carbon filament lamp this brilliancy is about a hundred times that of the ordinary candle and in a tungsten filament lamp from 200 to 2,500 times. Thus while clear bulb lamps should always be shaded, in many cases the bare lamp must be used for various reasons. Under these circumstances "frosted" lamps have been occasionally used in place of clear ones, since the brilliancy is reduced about a hundred fold by frosting. Orignally, the frosting consisted either of acid etching or of a coat of mineral paint sprayed onto the surface of the bulb.

Reprinted from "History of the Incandescent Lamp," by John W. Howell and Henry Schroeder, of the General Electric Company.

The higher cost and slight loss of light due to absorption by the frosting prevented the use of frosted lamps in many places where they should have been used. These objections, and the limitations they imposed on the frosted type of lamp, have been eliminated by a recent invention



Before Treating *After Treating*

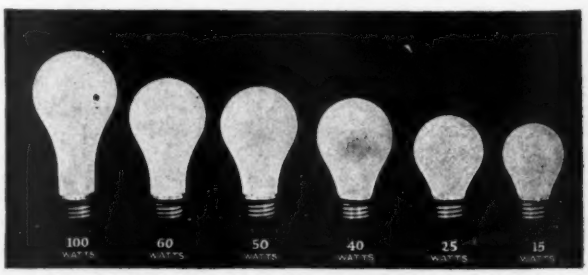
PHOTOMICROGRAPHS OF INSIDE FROSTING

If a lamp bulb is acid frosted on the inside, the bulb becomes fragile. Marvin Pipkin restored the strength by a chemical treatment which rounded out the minute cracks made by the acid frosting. Inside frosting absorbs less than two per cent of the light, which is about one-third that absorbed by outside frosting.

of Marvin Pipkin of the General Electric Company, which not only cuts the loss by absorption to a third of its former value, but, since it is practical for quantity production, has reduced the price of the lamps.

The advantages of frosting an incandescent lamp on the inside of the bulb have been realized for many years, but until recently no satisfactory method has been devised. It is obvious that a lamp having a smooth outer surface, will be more apt to stay clean than one having a roughened outer surface.

The absorption due to frosting is considerably less with inside than with outside frosting. If the frosting is on the outside, the light from the filament goes through the glass wall of the bulb to the irregular frosted surface where some of it is diffused. The remainder of the light is reflected back through the glass to the opposite wall of the bulb. This process is repeated again and again until most of the light gets out. Some light, however, is absorbed each time



STANDARD LAMPS

These are the six standard lamps of the new line which replaced the forty-five different types and sizes for standard lighting service previously used. The lamps have a new shaped bulb which is frosted on the inside.

it passes through the glass. If the frosting is on the inside surface of the bulb, the cross reflections from the frosting

do not have to pass through the glass walls of the bulb each time, which may be an explanation for its lesser absorption.

The ordinary acid frosting on the inside of the bulb weakens the bulb and renders such lamps subject to breakage. It etches the bulb and causes minute cracks or splits to appear just below the surface of the glass. When the bulb is evacuated, the inside surface of the glass is under tension from the air pressure on the outside surface, and the cracks on the inside surface of the bulb cause it to break easily just as a steel truss will break with a crack at the bottom and pressure on top. If the frosting is on the outside, the glass is not materially weakened, as then the etched glass surface is on the outside under compression, the compressive strength of a piece of glass being greater than its tensile strength.

It is a well known fact that if a round hole is drilled at the end of a crack or split in a steel truss, it will withstand a greater weight. Mr. Pipkin discovered that if an inside frosted lamp is subjected to the proper treatment, the entire area of the inside surface will become etched in such a manner as to round out the bottoms of these cracks. The effect of this action is to restore the strength of the bulb to its former value. This he accomplished by chemically treating the inside of the bulb after it had been acid etched.

The new inside frosted lamps were first put on the market in 1925 with a new shape of bulb which is considered more pleasing in appearance and which is expected to replace many of the different shaped bulbs used in the past. This new standard line of six lamps is intended to replace approximately forty-five different lamps heretofore supplied.

The Unit Machine

The process of making a lamp consists of a succession of steps, each of which is an independent operation. A glass tube is made into a stem, a glass rod welded to it and little wire supports set into it to hold the filament. The filament is draped on anchors and pinched fast to the ends of the leading-in wires. The stem with its filament is inserted in the bulb and the stem and bulb are fused together. The air is exhausted and gas inserted if it is to be a gas-filled lamp. The base is cemented on. The leading-in wires are soldered to the base. The lamp is tested, wrapped and packed in a carton and then in a case. It is one long succession of delicate little operations.

One of the difficulties has been the problem of maintaining a balance in the quantity of the different parts manufactured. This had led to the necessity for storage of parts between operations. It has required a great deal of floor space and an expenditure for labor in handling and rehandling materials. Various individual machines used in the different operations ran at their own particular speed of efficiency and the effort was to keep a balance amongst the number of machines or operators in each department that would maintain a uniform production.

Soon after the close of the war, when industrial men began to turn their thoughts once more to plant improvements, W. R. Burrows began to see the possibilities for correlating the machine steps in the manufacture of a lamp. His first move was to take one of the various machines out of each department and set them up side by side to work in sequence with each other and with the different hand operations required. There gradually developed the conception of balancing these machines and the hand work processes so that materials would flow evenly into the unit of machines and all storage of parts between operations might eliminated.

By gradual evolution, the result of endless experiment and a tremendous amount of machine development, this very end was accomplished. Out of it finally came a unit lamp-making machine, one single combined mechanism

UNIT MACHINE

In this machine, having four operators making standard lighting lamps, the heretofore individual processes in lamp making are co-ordinated. The result has been that the floor capacity of lamp factories has been tripled and the output per operator doubled.

into which glass bulbs, tubes and rods, filament wire, anchor wire, bases and packing materials are fed. Out of the other end come finished lamps, marked, tested, wrapped, packed and laid in a case upon a conveyor belt that carries them away to be shipped.

In the present unit machine there are three to seven operators, depending on the type of lamp, turning out twice as many lamps per operator as were made by the old departmental method. It is expected that machines will soon be available requiring a lesser number of operators, perhaps as low as two, in which much of the hand work now done will be made automatic. Another great advantage of the unit machine is that it has tripled the capacity for a given floor space, because it has eliminated the storage of parts between operations.

These advantages have materially reduced the cost of manufacture, making possible a reduction in prices. At the present time the price of lamps is more than one-third below the pre-war level, an accomplishment which few industries can claim and which is even more remarkable when it is considered that the present average price of commodities is over 50 per cent above their pre-war figure.

Another interesting things about the unit machine is that the quality of lamps has improved through its use. This is due to the ability to locate definitely imperfect manufacture in any given part of the lamp which was almost impossible to fix by the old departmental method where the part may have been made in any one of a great many individual machines.

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CONTRIBUTIONS

THE EDITOR welcomes practical articles on all subjects related to GLASS MANUFACTURING. Such articles, if accepted, will be paid for at our usual rates.

Vol. 8 OCTOBER, 1927 No. 10

CONTENTS

	Page
The Plate Glass Casting Process According to Bicheroux	231
Gaseous Fuels for Furnace Heating	238
Regeneration in Glass-Tank-Furnaces	239
Bureau of Standards Circular on Ultraviolet Glass	240
The History of the Incandescent Lamp	242
Editorial:	
Ultraviolet Transmitting Glasses	244
Technical Consultation Service:	
Manufacture and Testing of Ultraviolet Transmitting Glasses	245
Effect of Color on Heat Transmissibility of Glasses	245
Discussion on Glass Industries Refractories	246
Fuel Engineers to Meet at St. Louis	246
Glass Making Advanced at Ford's St. Paul Plant	247
Recent Patents	248
The Glass World and What It Is Doing:	
Glass Distributors' September Meetings	250
Glass at the Canadian National Exhibition	250
Effect of New French Duties on American Trade	250
First Government Potash Test Encouraging	250
Window Glass Prices Reduced	250
Outside Frosted Lamps Not Abolished	251
Reduces Price of Ultraviolet Transmitting Glass	251
Rossford, Ohio, Interests Get Bicheroux License	251
Plate Glass Production in August	251
Trade Activities	252
Industrial Publications	252
Personals	253
Recent Deaths	253
Coming Meetings	253
What the World Wants	253
Glass Stock Quotations	253
Current Prices of Glass-Making Materials	254
Monthly Summary of United States Foreign Commerce in Glass	254

CLASSIFIED BUYERS' GUIDE, PAGE 18
INDEX TO ADVERTISEMENTS, PAGE 20

Ultraviolet Transmitting Glasses

Sixteen months ago, in an editorial entitled: "Wanted, a New Glass at a Low Price," the hope was expressed that science would, before long, be able to supply a glass that could transmit ultraviolet rays, using the following words:

"That the solution of this problem is only a question of time and insistence of demand is the firm belief of those who have witnessed that in the majority of instances, science has been able to fill any such need, and fill it satisfactorily."

At that time there was no glass manufacturing concern in this country that was producing ultraviolet transmitting glass in commercial quantities. At the present writing there are several. It is no exaggeration to say that with this problem solved, the flat glass industry is face to face with a great opportunity for development.

The Equitable Trust Company of New York is reported to have given orders to equip 18 floors of its gigantic new building on Broad and Wall streets with ultraviolet transmitting glass. The effect of the new glass on the health of school children has been noteworthy. Dr. J. Bell Ferguson, Health Officer of Smethwick, England, reports that thirty boys whose ages ranged from 9 to 11 years in the test class equipped with ultraviolet transmitting glass gained during the school year an average of 6.11 pounds in weight, as compared with a gain of 2.83 pounds in the control class, having ordinary window glass. The gain in height was 1.86 inches as against 1.22 inches. Gain in haemoglobin content of the blood was reported to be 16.14 per cent as compared with 7.53 per cent in the control class.

If these results are further substantiated, the effect of this invention on city architecture promises to be considerable. It will tend to create a demand for window glass and plate glass, hitherto undreamed of. There will be a growing tendency to replace brick and stone by glass. Modern steel construction which has eliminated the need of heavy walls has made possible the skyscraper of steel and glass. This invention may bring it to a realization. Apartment houses, office buildings, homes and hospitals, equipped with ultraviolet transmitting glass means that the indoor worker will acquire a coat of tan like the outdoor man, and keep it through winter and summer. It will cause better health and more happiness. The influence of exposure to the full effects of sunlight on the life of the city dweller, the saving due to decreased sickness, greater efficiency, increased earning power, promises to be enormous.

However, there is a danger in the situation. The Bureau of Standards, always ready to supply the needs of industry for unbiased, accurate scientific information, has issued a report on the comparative efficiency of ultraviolet transmitting glasses. This timely study, made with the completeness which characterizes the work of this remarkable institution, shows considerable degrees of efficacy of various glasses, with reference to ultraviolet transmission. As in all other cases, there is quality to be considered.

The situation is somewhat similar to one that occurred years ago, when commercial fertilizers first came into general use on the farms. At first it was thought that fertilizers were all the same, as regards their effect on the crop producing qualities of the soil. Today every farmer knows

that there are various grades of fertilizers; that it sometimes pays to buy less efficient materials and save the price, and that at other times the highest grade fertilizers will be the most economical. The time came when fertilizer manufacturers voluntarily began to report analyses of their goods on the tags, giving the exact amount of plant food present in each bag of fertilizer. State laws later made this practice obligatory on every one manufacturing or selling fertilizer. It has proved to be of incalculable value to the fertilizer industry and to the farmers.

A similar procedure should be adopted by manufacturers of ultraviolet transmitting glasses. It will prove to be sound policy to state frankly the quality of the glass, with reference to the property for which it is sold. At the present time the public has only a vague idea as to what it is all about. But when people see results, they are not slow to learn. All efforts should be made to avoid giving the impression that ultraviolet transmitting glass is a passing fad, not substantiated by actual experience. Once such a feeling was established, it would take years to overcome the revulsion caused thereby, to the great loss of the glass industry and of the world. It will prove to be the part of wisdom to keep advertising literature well within the bounds of what has been proved, and not to allow hopes and fancies to roam unchecked. The flat glass industry should be careful not to make statements that will have to be "debunked" later.

Technical Consultation Service

Manufacture and Testing of Ultraviolet Transmitting Glasses

QUESTION 109—Please give us names of firms manufacturing ultraviolet transmitting glasses, the amounts of ultraviolet rays that are transmitted by the various kinds of glasses now on the market and the methods used to determine this property.

ANSWER.—The following are the names of firms manufacturing ultraviolet transmitting glasses, in alphabetical order:

American Window Glass Company, Pittsburgh, Pa.
Corning Glass Works, Corning, New York.
Pittsburgh Plate Glass Company, Pittsburgh, Pa.
Vitaglass Corporation, New York.

The following foreign firms manufacture ultraviolet transmitting glasses:

German Plate Glass Corporation, Grünenplan, Germany.
Jena Glass Works, Schott und Genossen, Jena, Germany.
Pilkington Brothers Ltd., St. Helens, Lancs., England.

With regard to the amounts of ultraviolet rays that are transmitted by the various glasses now on the market, we have referred this question to the Bureau of Standards, which has furnished us with a detailed report of work carried on by this institution. On account of the great importance of this subject, the report has been reprinted in full on page 240 of this issue.

As for the methods, used to determine the amounts of ultraviolet rays transmitted, the Bureau of Standards has furnished the following information:

Spectral transmissions in the ultraviolet may be determined by photographic methods—for example: Howe, Phys. Rev. (2) 8. p. 674; 1916; see also Bur. Standards Tech. Papers Nos. 119 and 148 on ultraviolet transmission of glasses.

A quick and reliable method of determining the transmission of glass is radiometric, in which the radiation from a quartz mercury arc is dispersed by means of a spectrometer having lenses and a prism of quartz and the intensities of the emission lines at 254, 265, 280, 303, 334, 365 and 405 μ are measured with a thermopile. The source might be a carbon arc having electrodes impregnated with nickel, aluminum, etc. The quartz mercury arc is preferred because it is steady-burning. It is commonly used by physicists and is well adapted for testing the transparency of window glass since glass does not have narrow absorption bands. The method of observation is to note the decrease in intensity of the spectral line (the galvanometer deflection) when the glass is interposed. The ratio of the two intensities give the per cent transmitted.

An article entitled: "Methods and Apparatus in Spectroradiometry," by W. W. Coblenz of the Bureau of Standards, published in the Journal of the Optical Society of America and Review of Scientific Instruments, gives information regarding the use of this instrument.

Fred. M. Locke, of the Fred M. Locke Research Laboratory, Victor, New York, has developed a glass that transmits ultraviolet rays. A description of this invention may be found in this journal, Vol. 7, No. 6 (June, 1926), on page 136. Reports of tests made on the effect of ultraviolet transmitting glass in schools and hospitals in England are published on page 33, Vol. 8, No. 2 (February, 1927). H. P. Hood has given a complete description of a new ultraviolet transmitting glass, developed by the Corning Glass Works, on page 287, Vol. 7, No. 12 (December, 1926), of THE GLASS INDUSTRY.

Effect of Color on Heat Transmissibility of Glasses

QUESTION 110—In the July issue of the THE GLASS INDUSTRY, page 156, Mr. McSwiney makes the following statement: "Owing to the marked differences in radiant heat transmissibility of glasses of different colors, the lines of flow of glass * * *"

The effect of color on heat transmissibility of glasses is one of very great interest to us. We have, however, been unable to find accurate data on this subject.

We would like very much to know if Mr. McSwiney had access to accurate data when making the above remark.

ANSWER.—Although the matter is one of great practical and theoretical value and interest, there has been almost no data published and little accurate work done on the effect of color on the diathermacy of glasses. Zsigmondy did a little work along this line about thirty years ago and I believe Henrivaux in his book on glass gives results of a few determinations made on different glasses, but the work in both cases was limited in scope. I believe that the laboratory of a prominent glassworks in England has done some little work of this nature and it is possible that the same is true of a well-known American laboratory, but whatever information these companies have is not generally available.

Most of the interest in the matter has so far been connected with the preparation of athermanous glasses; for this reason, all the little work which has been done is on glasses at ordinary temperatures. It is probable that you would be most interested in the relative diathermacy of glasses of different colors at ordinary temperatures, but, from a glass furnace standpoint, the point of interest is the relative transmissibility at or near melting temperatures, and this may be very different from that of different glasses at ordinary temperatures. Moreover, from a quantitative standpoint, the problem is further complicated by the fact that the diathermacy of any glass will depend to a considerable extent on the source of the radiation. It is probable that the composition of the base glass, entirely aside from the color, may have a very appreciable effect on the transmission of radiant heat, as is the case with the transmission of very short wave lengths.

The determination of heat transmissibility of glasses at high temperatures is, of course, a very much more difficult problem than the determination on the same glasses at ordinary temperatures. As you know, some coloring materials—those which owe their coloring power to their existence in the glass in the form of a colloidal suspension—are present as such only in part or not at all at the melting temperatures, but separate out in the colloidal coloring condition as the glass cools. Such glasses are the opal or opalescent glasses, amber, ruby, etc. The heat transmitting power of these glasses may be proportionately very much higher at melting temperatures than in the cold condition.

From a practical standpoint, the difference in diathermacy of glasses at high temperature is shown by the drop in tempera-

ture through a mass of glass which is heated only from one side, such as the glass in a tank, and, indirectly, by the formation through surface radiation of chilled skins or "enamels" of different thickness on the cooling of glasses of different colors.

Determination of these temperature drops are only occasionally made, but evidence of such difference in temperature drop through glasses of different colors by difference in increase in the viscosity of the glasses is a very common observation. For example, a flint glass a foot below the surface in a melting tank will be very fluid while a dark green glass of nearly the same composition with the same surface temperature may be almost too viscous to flow at that depth.

Such a temperature difference cannot be due to a pronounced difference in the heat conductivities of the glasses, for observation shows that the heat conductivity of different glasses is too low to account for more than a small proportion of the heat transmitted through the glass and that the difference in the heat conductivity of commercial glasses of the same base composition is relatively slight. Part of the increase in viscosity of the glasses at increasing distance from the heat source can be due to a possible effect on the viscosity temperature relations of the glass by the small proportion of coloring material present influencing the molecular structure or the degree of molecular association of some of the glass constituents, in fact, I am inclined to feel that in some glasses such is the case; however, this can account for only a small portion of the apparent difference in viscosity, and it can be assumed that, in general, the difference in viscosity at the same distance below the surface of two glasses of different color but of nearly the same composition and having the same surface temperature is due to differences in rate of radiant heat transmissibility.

Observation of the rate of viscosity increase through the glass near the melting temperature, when glasses of nearly the same depth of color in the cold condition are considered, indicate that the diathermacy of the green glasses is much lower than that of glasses of other colors; this is true not only of glasses which have nearly a pure green color at ordinary temperatures, or of the common dark green iron glasses, but also of those glasses the color of which contains a nominal amount of green but in which some other color predominates. For example, the temperature drop through a copper glass—which is blue with a green cast—appears to be much more rapid than that through a cobalt glass which is blue with a purple cast; the rate of drop through a chrome green glass appears to be very much more rapid than that through a blue or ruby glass, and even a uranium glass which may be more on the yellow than on the green appears to have a high rate of temperature drop.

I have made a few temperature determinations at different depths in glass tanks, some of which are included in the latter part of my article on glass flow [which will appear in an early issue]. and find that in these cases the viscosity increase is actually in the same order as the temperature drop.—D. J. McSWINEY.

[Note—Readers who have investigated the subject discussed above, are invited to express their views.—TECHNICAL EDITOR]

Discussion on Glass Industries Refractories

At a meeting earlier in the year of the Pittsburgh District Section of the American Ceramic Society, Donald W. Ross, of the Findlay Clay Pot Company, gave a brief review of the refractories used in the glass industry, followed by lantern slides to illustrate the points mentioned. The talk was largely a review of the generally accepted principles and contained but little new material. Glass pot furnaces, particularly the care of the siege was first discussed. The subject of pots was taken up and it was stated that good pots are frequently lost during the heating up, preparatory for use in the furnace.

Reference was made to silica brick crowns for tank furnaces and particular attention drawn to the fact that during heating, these crowns expand and on cooling off again, they contract, but that the expansion the first time the crown is heated up (first fire) is frequently greater than it is on the later heatings.

It was noted that in case the silica content of refractories for use above the metal line is much greater than that indicated by the formula $Al_2O_32SiO_2$, dust arising from the melting batch and settling on the walls causes them to be eaten away smoothly. If the silica content is approximately the same as, or less than indicated by this formula, the silica is washed away by the flux, but much of the alumina of the clay remains behind in the form of large plates of corundum, which give the surface of such blocks a reddish-brown shiny appearance. Such corundum plates are frequently well developed on the melting side of the cover blocks of the bridge.

The great prevalency of cracked tank blocks in all tank furnaces, indicates how important a matter their resistance to thermal shock is.

Among the slides, several types of bridge walls were shown. The matter of sunken throats was mentioned. Although it may eventually prove that sunken throats are not particularly suited to the manufacture of certain opal and other glasses, such as dark green and black glass, through which radiation is relatively low, sunken throats appear to be quite satisfactory for use in the manufacture of many clear glasses, such as bottle glass.

It appears probable that it is well to have the forebay (entrance to throat) relatively wide along the bridge wall. It may even prove that it is desirable to have this forebay several times as wide as the flowhole through the bridge or throat. Sunken throats appear to furnish relatively cool glass to the refining end of the tank, which apparently deploys to all parts of the refining end, avoiding the formation of hot streams in the refining end.

Such gradual upward movement of the glass apparently results in less wear of the tank blocks in the refining end. It may even prove advisable to follow this matter further and to construct tanks in which the top of the flowhole is a foot or more below the floor level of the tank.

Fuel Engineers to Meet at St. Louis

The campaign being conducted by the Fuels Division of the American Society of Mechanical Engineers for the better and more efficient use of fuels will come to a head this year at the First National Fuels Meeting to be held in St. Louis, Mo., October 10 to 13 inclusive. Determined efforts are being made, with every prospect of success, to make this, the initial meeting of its kind, a most notable event. Headquarters will be at the Statler Hotel and at the meetings papers of a general nature, of interest to all users of fuel, and special papers on fuels in industrial furnaces, central stations, etc., will be presented.

On Monday morning, October 10, Prof. S. W. Parr, of the University of Illinois will deliver an "Address on Fuels." At a general session in the afternoon there will be heard: "American Fuels Resources," by O. P. Hood, chief engineer, U. S. Bureau of Mines; "Combustion and Heat Transfer" by Prof. R. T. Haslam and H. C. Hottel, Massachusetts Institute of Technology; and "Recent Developments in Low Temperature Coal Carbonization," by D. H. Savage, Combustion Engineering Corporation, New York.

At the industrial session on Tuesday, the following papers will be given: "The High Cost of Fuel Saving," W. Trinks, Professor of Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh; "The Relative Values of Gaseous, Liquid and Solid Fuels," F. J. Ward, Professor, Fuels and Gas Engineering, Massachusetts Institute of Technology; "Application of Powdered Fuel to Smaller Boiler and Industrial Installations," H. Kreisinger and A. B. Wolle, Combustion Engineering Corporation, New York.

At the power plant session modern boilers and furnaces will be discussed. In the general session the program includes: "The Clinkering of Coal Ash as Related to Laboratory Fusibility Determinations," A. C. Fieldner, W. A. Selvig and P. Nicholls, U. S. Bureau of Mines Experiment Station, Pittsburgh; "Factors Governing the Purchase of Fuels," Morgan B. Smith, engineer, General Motors Corporation, Detroit; "Refractories for High Temperatures," Stewart Phelps, director of research and tests, American Refractories Institute Fellowship, Mellon Institute, Pittsburgh.

On Wednesday, at the industrial session, W. B. Chapman, vice-president of Chapman Engineering Company, will present a paper on "Progress in Gas-Producer Practice," followed by "The Use of Fuels in Brick Kilns," W. E. Rice, U. S. Bureau of Mines, Pittsburgh; and "The Burning of Liquid Fuels," by Ernest H. Peabody, President, Peabody Engineering Corporation, New York.

At the power plant session on Wednesday, stokers, air-preheaters, and automatic combustion control will be discussed. At the general session on Wednesday the subjects for discussion will be coal mining and preparation, dry quenching coke, smoke prevention. All of Thursday will be devoted to "Smoke Abatement."

Glassmaking Advanced at Ford's St. Paul Plant

Floor-Level Furnace and Electrically Heated Annealing Lehr Feature Newest Continuous Ford Unit

The newest plate glass manufacturing plant of the Ford Motor Company is located at the Twin Cities branch, St. Paul, Minn., an ideal point from which to supply branches west of the Mississippi with its product.

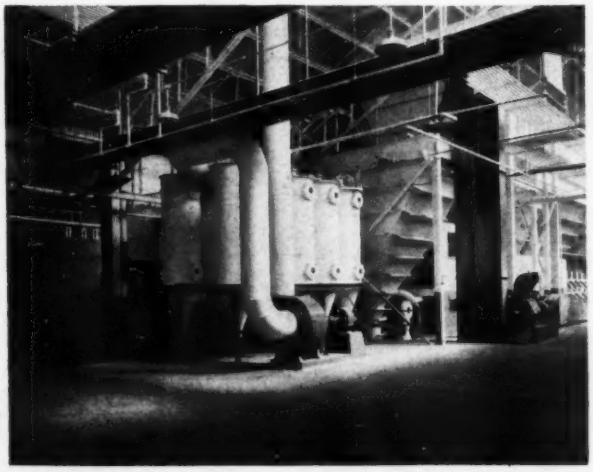
The glass unit is situated inside the main building of the branch, where a portion of the craneway was adapted to accommodate the manufacturing equipment—the melting tank, the lehr, and the grinding and polishing conveyor lines. By this arrangement crane facilities were provided for the entire unit.

There is a particular advantage in having the melting tank in the craneway. Manual lifting of fire bricks and tank blocks when the tank is repaired or relined is eliminated.

One feature of the St. Paul plant which represents a decided advance over previous installations is that the floor, or bottom, of the melting tank is flush with the floor of the plant. This makes much greater headroom over the crown, and places the rolling machine, the annealing lehr, and the primary cutting line at the same elevation as the plant floor. In both the company's other continuous plate glass plants (at Highland Park and Fordson), the furnace, the rollers, the lehr, and the primary cutting line are elevated above the plant floor, making necessary the introduction of a downward slanting belt conveyor to carry the glass to the level of the grinding and polishing lines.

Another improvement is found in the annealing lehr, which is heated by electricity, rather than by gas, which is the means used at the other continuous plants.

The reversing valve, which controls direction of the gas and air supply of the regenerative tank furnace, and the cooling fan are located in the basement beneath the tank. Bins for storage of silica sand, limestone, soda ash, salt cake, arsenic, charcoal, and cullet are situated near the charging platform. The equipment for mixing the batches, each of which weighs eight hundred pounds, is located directly above the "doghouse," the projecting rectangular lip through which the furnace is charged. As at the Highland Park plant, the charge goes directly from the mixing room into the doghouse by means of a chute. A skip hoist bucket is employed to elevate the raw materials to the mixing room.



DUST COLLECTORS, STORAGE BINS, CULLET CRUSHER AND CONVEYOR, AND SCALES FOR WEIGHING RAW MATERIALS

Raw material bins, scales for weighing ingredients, and mixing apparatus are protected by dust-tight inclosures and a dust-collecting system.

The melting tank-type furnace at the St. Paul plant is the largest in the Ford glass industry. Its capacity is 450 tons, and it has a drawing capacity of thirty tons daily. The tanks at the Fordson glass unit have a capacity of four hundred tons, and a daily drawing capacity of twenty-six tons each. The Highland Park glass tank is still smaller, having a total capacity of 350 tons, and a daily drawing capacity of about twenty-three tons. Heating the St. Paul plant furnace requires 170,000 cubic feet of gas per hour. This is manufactured in the plant's producer gas unit, located on the river bank.

The first flow of molten glass started from the St. Paul melting tank on April 29, 1926. Previous to being put in service the furnace was heated by wood cut on the bank of the Mississippi, which was fired beneath the checkerwork. A temperature of 900° Fahrenheit was attained with wood fire before the completion of the preheating process was taken up with gas. The tank gave eleven months of continuous service before it was necessary to shut it down for repairs.

THE GRINDING AND POLISHING LINES, TURNTABLE, AND THE ANNEALING LEHR

The rolling machine at the St. Paul glass unit is of the twenty-four-inch drum type, rolling a sheet of glass three hundred thousandths of an inch thick and forty-three inches wide. The electrically heated annealing lehr is 490 feet in length. The Highland Park lehr is 464 feet long; that at Fordson 442 feet. All brickwork and insulating material composing the lehr structure are inclosed in a sheet-iron covering, so that nothing except the worm-gear drive housing is exposed. It is necessary to apply heat for only one-third of the length of the lehr. The section containing no heating elements is kept at proper temperature by heat radiated from the cooling glass.

Twenty-nine grinding, fourteen smoothing, and thirty-six polishing machines complete the work of plate glass manufacture at St. Paul.

All electric starters, switches, and conduits for each grinding, smoothing or polishing machine are located inside the machine leg and cover. Water and rouge pipes are all concealed in the foundation, leaving nothing but the machine itself visible, which adds to the clean-cut appearance of the line.

Sand levigating tanks are located overhead at one side of the grinding line, and in line with the water filter, rouge washer, circulating system and garnet levigators. Sand for grinding is mined one hundred feet beneath the building and conveyed to the electric screen and pump which distributes it to the proper tank.

The unit is an extremely compact installation. Finished glass is assembled into windshield frames only four hundred feet from where the raw materials enter the melting tank.

From *Ford News*, Sept. 8, 1927.

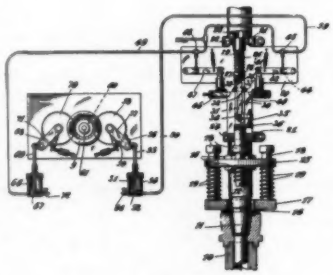
The Collector of Customs at New York recently issued a statement to the effect that, beginning September 11, plate glass obscured by coloring matter introduced while in the molten state, is dutiable at the rate of 17½ cents per square foot, plus 5 per cent, under paragraphs 222 and 224 of the Tariff Act of 1922.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

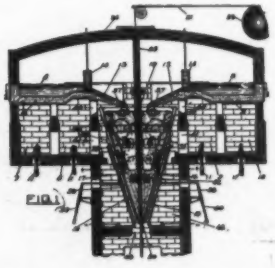
METHOD AND APPARATUS FOR REGULATING GLASS MACHINES. U. S. 1,640,944. Aug. 30, 1927. Peter Kucera, Connellsville, Pa., assignor to the Capstan Glass Co. Filed 3/3/22. Provides a purely automatic arrangement for maintaining mold charges within limits much closer than can be maintained by hand regulation. The change in volume of a charge delivered if over or under a predetermined limit operates indicator or actuates mechanisms which correct the variation. The indicators or the actuating mechanisms are controlled by the thickness of glass between the presser plunger and the bottom of the mold. If this thickness is less than a predetermined limit the plunger telescopes further into the mold than normally and the additional telescopic movement actuates an indicator or a motor mechanism which operates controls to slightly increase the next charge. The effect of the regulation immediately appears in the next charge.



MACHINE FOR FORMING GLASS ARTICLES. U. S. 1,641,497. Sept. 6, 1927. Richard La France, Toledo, O., assignor to the Owens Bottle Co. Filed 4/22/24. There is provided on each head or unit a plurality of gathering molds each comprising a plurality of mold cavities, so that a comparatively large number of mold charges are gathered by each head. Novel features include an improved cut-off mechanism comprising separate knives for the several molds on each head, which prevents the chilled cut end of glass severed by one knife from falling back into the tank at a point where a succeeding mold gathers its charge, also mechanism by which all of the bottles of each head are discharged simultaneously.

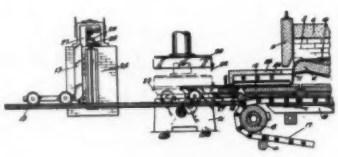
SHEET-GLASS APPARATUS. U. S. 1,641,920. Sept. 6, 1927. Henry F. Clark, Belle Vernon, Pa., assignor to the Window Glass Machine Co. Filed 9/11/26. An improved form of drawing mechanism for raising a sheet of glass as it is drawn from a bath, comprising a pair of traction rolls, each roll in the pair being movable toward or away from the sheet, and yieldable means associated with each roll for causing them to normally occupy a position immediately alongside the normal plane of travel of the glass sheet.

METHOD AND APPARATUS FOR MAKING WIRE GLASS. U. S. 1,641,932. Sept. 6, 1927. Joseph A. Reece, Toledo, O., assignor to the Libbey-Owens Sheet Glass Co. Filed 3/19/21. In an apparatus for producing wire glass, a wedge-shaped container having a substantially vertical longitudinal slot therethrough, means for feeding a sheet of wire mesh downwardly through the slot so that it emerges at the lower edge of the wedge, means to supply molten glass to the upper portion of the container, the molten glass overflowing down the sides of the wedge onto the faces of the sheet of wire mesh, heating means within the container, and electric heaters outside the wedge for applying heat to the streams of molten glass as they flow down the wedge. This apparatus, when properly adjusted, has no moving parts, and the operation is simple and continuous. The glass which goes to form the outer faces of the sheet, contacts with nothing, except the surrounding heated atmosphere, at any point after leaving the original container until the sheet is formed and set.



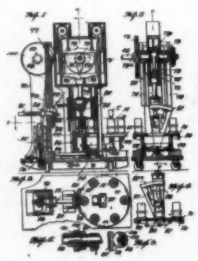
APPARATUS FOR FEEDING MOLTEN GLASS. U. S. 1,641,133. Aug. 30, 1927. Julius H. O. Bunge, London, England, assignor to the Hartford-Empire Co. Filed 10/22/25. A vertically adjustable gate, preferably of accurate shape, which will form a continuation of the wall of the feeding chamber and co-operate with it to provide a well in which a discharge-controlling plunger may properly operate; which will prevent the dross or impurities from entering the feeding chamber; which will accurately control the rate of flow of the under-surface glass entering the feeding chamber beneath the gate and the distribution of the glass about the plunger; and which will permit of an unobstructed passage above the gate of the flames or hot gases from the forehearth to the feeding chamber.

METHOD OF PRODUCING PRESSED SHEET GLASS. U. S. 1,641,806. Sept 6, 1926. Enoch T. Ferngren, Toledo, O., assignor to the Libbey-Owens Sheet Glass Co. Filed 11/24/24. The method of forming plate glass, consisting in flowing molten glass in ribbon formation upon a series of molds which are spaced from one another, in maintaining the fluency of the glass while it is received by each mold, in cutting the ribbon between the molds to form detached sections, in flattening each section as it is detached, and in applying heat to its surfaces to give polish thereto.



METHOD AND APPARATUS FOR FORMING SHEET GLASS. U. S. 1,641,948. Sept. 6, 1927. James C. Blair, Toledo, O., assignor to the Libbey-Owens Sheet Glass Co. Filed 2/28/25. Means for forming relatively thick edges on glass sheets for preventing the narrowing of the sheet. Stationary shoe members adapted to contact with the edges of a sheet of glass being drawn from a mass of molten glass in a manner that the edges will be held against lateral movement, thus preventing narrowing of the sheet.

GLASS-WORKING APPARATUS. U. S. 1,642,430. Sept. 13, 1927. Theodore C. Steimer, deceased, late of Pittsburgh, Pa., by Charles M. Steimer, executor, of Zanesville, Ohio, assignor, by mesne assignments, to the Hartford Special Machinery Company. Filed 2/12/10. The invention herein claimed relates to mechanism for fabricating pressed or blown articles from charges of molten glass, and is illustrated as applied to a press for making table ware and the like. The object is to improve the operation of glassware fabricating machines, more especially by providing improved driving mechanism for turning a mold table step-by-step to bring the molds carried by the table into successive working positions.

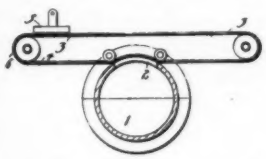


CONSTANT-TEMPERATURE HEATER FOR SHEET-GLASS-DRAWING MACHINE. U. S. 1,641,807. Sept. 6, 1927. William A. Gibson, Charleston, W. Va., assignor to the Libbey-Owens Sheet Glass Co. Filed 3/2/23. In a sheet-glass-drawing machine, a hollow container adjacent the path of travel of the sheet, a mass of material in the container whose melting point is slightly higher than the temperature at which the sheet is to be maintained, means for

heating the material at intervals to keep it in a partially melted condition, and pressure-controlled means operated by the change in volume of the material between the solid and liquid states, which turns the heat off before the material is entirely melted, and turns the heat on before it has entirely solidified.

PROCESS AND APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,641,883. Sept. 6, 1927. Enoch T. Ferngren, Toledo, O., assignor to the Libbey-Owens Sheet Glass Co. Filed 1/22/26. The combination with a sheet glass drawing apparatus and rotatable sheet edge gripping rolls of an adjustable cooling means for localizing the effect thereof upon the glass immediately adjacent the sheet edges and means for adjusting the said cooling means independently of said edge gripping rolls.

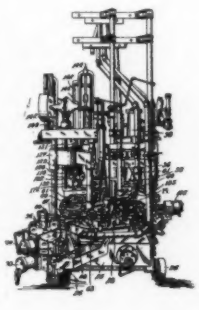
FORMATION OF LABELS, SYMBOLS, AND THE LIKE ON GLASS CONTAINERS. U. S. 1,640,076. Aug. 23, 1927. William Clifton Hart, Adelaide, South Australia. Filed 3/24/26. The basic principle underlying this invention consists in the provision of means, combined with the blowing of glass containers and while the glass is in a viscous state, whereby the labels are colored or multi-colored, so that the coloring will melt and become adhesively part and parcel of the label or symbol desired on the container, thus obviating the use of paper labels commonly used and now affixed by separate machines after the containers are cool.



The process embodied in the invention consists firstly, in grinding, filing or cutting the outlines of the label or labels or symbols completely through the molds so that the glass in its viscous or molten state will be blown into the mold and to the line of the label surface desired, and secondly, simultaneously with the blowing and while the glass is in its viscous state, causing the viscous glass at the label portion of the mold to come into contact with a pad or pads, or transfers in a color block holder, or a moving belt, or film carrying colors, which while conforming to the label or symbol, in one or multi-colors, melt into the glass with the result that the container is blown with the colored label or symbol as a part thereof.

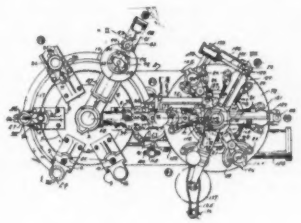
SHEET-DRAWING APPARATUS. U. S. 1,641,894. Sept. 6, 1927. Nestor Manbourg, Lancaster, O., assignor to the Libbey-Owens Sheet Glass Co. Filed 10/13/24. In a sheet-glass-drawing apparatus, including a draw-pot having a bath of molten glass therein, and a lip-tile arranged above the pot, a removable member interposed between the end of the lip-tile and the glass and extending below the surface of the glass, said member being adapted to be removed without interfering with said lip-tile.

GLASSWORKING MACHINE. U. S. 1,642,658. Sept. 13, 1927. Minot K. Holmes, Muncie, Ind., assignor to Hemingray Glass Co. Filed 12/1/24. Particualrly designed for the production of internally threaded glass electric insulators. In a glass working machine utilizing a pressing pin to be extracted from the finished article, means for presenting a series of molds successively to successive stations, a press plunger, an extracting plunger, a transfer basket formed to receive a circumferential series of press pins, a transfer arm arranged to receive pins from the extracting plunger and deliver the same to the transfer basket, a transfer arm arranged to receive pins from the transfer basket and deliver the same to the press plunger.



METHOD AND APPARATUS FOR ANNEALING AND COOLING SHEET GLASS. U. S. 1,641,896. Sept. 6, 1927. William L. Monro, Pittsburgh, Pa., assignor to the Window Glass Machine Co. Filed 2/12/24. It has been found that if a lehr tunnel of usual construction is used and all of the gases supplied to one end thereof are permitted to take their natural course through the tunnel, the gas stream above the glass will be hotter than the stream below and as a result the lower face of the glass sheet cools more rapidly, so that the glass is warped or bowed when delivered from the lehr tunnel. This provides substantially smooth and continuous streams of gases through the tunnel above and below the glass level, and amplifies the cooling effect of the lower stream relative to the upper stream by increasing the velocity thereof above its natural velocity.

GLASS PRESSING AND BLOWING MACHINE. U. S. 1,642,660. Sept. 13, 1927. Frank O'Neill, Toledo, O. Filed 2/19/24. This invention has utility in press and blow operations in the handling of molten glass, as in the manufacture of containers, especially wide mouth or open top ware, as tumblers, and even has application to paste mold produced articles involving relative shifting between the mold and the glass during ware forming. The illustration shows a plan view of an embodiment of the invention in a tumbler machine.



GLASS-MANUFACTURING MACHINE AND METHOD. U. S. 1,642,312. Sept. 13, 1927. Pancras Schoonenberg, Eindhoven, Netherlands, assignor to N. V. Philips, Gloeilampenfabrieken, Eindhoven, Netherlands. Filed 1/14/27. A method of continuously drawing tubes or rods being composed of several glass layers which are fused together consisting in supplying various currents of glass to a rotating member so as to form layers which are fused together, drawing the glass from the end of said member into the shape of a tube or rod. [See Patent No. 1,637,458, page 223, September, 1927, issue of this JOURNAL for cut.]

GLASS DECORATING. U. S. 1,642,441. Sept. 13, 1927. Oscar Hommel, Pittsburgh, Pa. Filed 9/1/21. If it is desired to color a portion of a glass object such as the hood of a headlight lens 3, shown in Fig. 1, to render that portion opaque or to diffuse the light through that portion, the inventor sifts a quantity of granular glass from a receptacle 4 having a wire mesh bottom 5 onto that portion of the lens 3 desired to be colored. Since the granulated glass is sifted immediately after the lens 3 is removed from the mold and by reason of its granular form is evenly distributed thereover the intense heat melts the granulated glass and it forms a stable glass sheet or casing over the portion 6 of the lens. The casing formed over the portion 6 of the lens is stable and cannot be scratched off nor will it peel when heated.

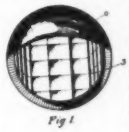
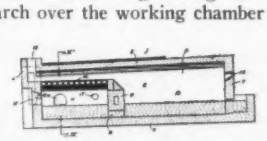


Fig 1

Fig 2

CONTINUOUS LEHR. U. S. 1,637,714, Aug. 2, 1927, Edwin S. Slick, Pittsburgh, Pa. The combination with a lehr conveyor, of a charging conveyor movable across the lehr conveyor, means for conveying articles to the charging conveyor, a displacer for moving one article at a time from the charging conveyor to the lehr conveyor and means for causing the displacer to move at one speed while transferring the articles from the charging conveyor and at another speed while returning to initial position.

GLASS FURNACE. U. S. 1,639,657. Aug. 23, 1927. Gregory D. Mantle, Pittsburgh, Pa., assignor to Mantle Engineering Co. Filed 10/8/26. A closed refractory arch over the working chamber and extending from the bridge wall to the forward or working end wall of the furnace. This arch, in effect, provides a muffle or circulating passage outside the working chamber by means of which a high temperature can be maintained in the working chamber without directly subjecting the glass in the chamber to the gases of combustion. This also prevents the gases of combustion from escaping through the working doors, and prevents interference with the circulation of the gases of combustion by reason of air entering the working doors.



The Glass World and What It Is Doing

News of the Industry

Glass Distributors' September Meetings

The Eastern Division of the National Glass Distributors Association held an interesting meeting at the Hotel Traymore, Atlantic City, September 14 to 16, under the chairmanship of S. C. Gilmore of the Hires-Turner Glass Company. Addresses were made by several of the members, the first being that of A. D. Dwelle of the Dwelle-Kaiser Company, Buffalo, who spoke on jobbers' problems, gave costs and cited discounts and conditions that must prevail in order to enable the jobbers to make a profit of 5 per cent. C. J. Gundlach, president of the Mississippi Wire Glass Company discussed trade conditions and the outlook for the future and urged his hearers to do everything in their power to maintain an adequate tariff and resist reductions.

W. L. Monro, president and general manager of the American Window Glass Company, E. F. Troutman of the Standard Plate Glass Company, B. C. Root of the Libbey-Owens Sheet Glass Company, R. M. Paxton of the Highland Glass Company, Washington, Pa., also addressed the meeting. Mr. Monro, in the course of his talk, said that the annual production capacity of the United States glass factories now amounts to 11,500,000 fifty-foot boxes and that something must be done by the manufacturers and jobbers to stop the inroads that are being made on the industry by foreign manufacturers.

Mr. Troutman spoke on conditions in the plate glass industry and Mr. Paxton said that conditions in his line indicated very light stocks in the hands of jobbers.

F. Stuart Fitzpatrick, assistant manager of the United States Chamber of Commerce discussed the present standing of trade associations.

An enjoyable banquet and entertainment under the management of Secretary Doerr was given at the Traymore Hotel on Thursday evening.

The Western Division also held a very successful meeting at the Congress Hotel, Chicago, Ill., September 20 and 21 under the chairmanship of A. E. Clerihew of Foreman, Ford & Company of Minneapolis. Many prominent glass men attended and gave their views on the trade situation.

Glass at the Canadian National Exhibition

The Canadian National Exhibition at Toronto, Ontario, an annual event, was held this year from August 28 until September 10 in the magnificent Exposition Buildings, located on the shore of Lake Ontario. Pilkington Brothers (Canada), Limited, showed various kinds of plate glass and cathedral glass. Of especial interest was an exhibit of very heavy plate glass, used for ship's bridges and for port lights. A number of beautiful specimens of tinted cathedral glass made an interesting showing. Among other kinds of glass on exhibition were samples of standard safety glass, wired cast and wired arctic glass, prism glass.

This well known concern has its main factory at St. Helens, Lancashire, England. The Canadian factory is located at Thorold, Ontario, with central offices at St. Catherines, Ont. Depots are located at Halifax, Montreal, Toronto, Winnipeg, Calgary, Edmonton and Vancouver.

The Consolidated Plate Glass Company of Canada, Limited, showed "Vioray," "The Health Giving Glass." This glass, it is understood, is a product made by Schott und Genossen, Jena, Germany. An exhibit of "Quartz-Lite," made by the American Window Glass Company of Pittsburgh, attracted a great deal of attention and those in charge of the exhibit reported numerous inquiries from home builders, and poultry farmers. The Canadian concern has offices at Toronto, Montreal and Winnipeg.

The Canadian General Electric Company occupied one of the largest booths of the Industrial Building, showing the manufacture of electric light bulbs. At the beginning of the assembling line inside frosted bulbs were supplied. The various operations, resulting finally in the completed electric lamp, were shown by experienced operators, working at a speed equal to that attained in the factory. This manufacturing unit attracted large crowds and proved to be one of the most interesting and instructing exhibits.

Effect of New French Duties on American Trade

Discussing in *Commerce Reports* the probability of a reduced volume of trade between the United States and France on a wide range of American commodities, because of the changes in the French tariff established in connection with the recent Franco-German treaty, effective September 6, imposing on certain lines of American goods duties four times as high as those applying to competing products from Germany, England, and other countries, Henry Chalmers, chief of the Division of Foreign Tariffs, Bureau of Commerce, states that with a view to relieving the situation, the United States has made representations to France, suggesting the suspension of any higher duties on American than on German or other goods pending the negotiation of a commercial treaty between the United States and France.

Unless the situation is modified, American exporters in the lines subject to the new fourfold general duties will, according to trade opinion, be practically excluded from the French market. Glass and glassware are in this class.

Concerns interested in the above products can learn the precise new duties now levied on their products, in France or Germany, by addressing a specific request to the division of Foreign Tariffs, at Washington, D. C.

First Government Potash Test Encouraging

The results of the first Government test made under the Federal potash act are both interesting and encouraging, though the beds encountered are probably not rich enough to have present commercial value, according to a statement by the Department of the Interior.

The first core test was made on public land in Eddy County, New Mexico. The site was not the first choice of the Geological Survey, nor even the fifth choice, certain restrictive conditions automatically excluding the cooperating departments from areas where the better showings had been indicated by drill cuttings. Under the conditions named it is surprising that the results obtained are so favorable as they are.

About 50 beds or groups of beds containing 2 per cent or more of potash (K_2O) were encountered between depths of 838 and 1,770 feet. The depth of the hole was 1,847 feet. Fourteen beds ranged in thickness from 1 inch to 6 feet 2 inches and in potash content from 3.10 to 16.47 per cent. They are described in order of thickness and shown graphically in a memorandum released by the Department of the Interior on August 29, 1927, and further discussed in a second memorandum released September 24.

On September 24 the Government announced that the second core test in New Mexico, made jointly by the Department of the Interior and the Department of Commerce under the Federal potash act, had disclosed numerous beds of potash, but that none were thick enough and rich enough to have prospective commercial value.

Predictions have been made that the recent discoveries of potash in the southwest will eventually mean the extinction, so far as the United States is concerned, of the European potash trust. George Steiger, chief chemist of the U. S. Geological Survey, has made the statement that "It is not unreasonable to suppose that the Texas-New Mexico deposits contain enough potash to supply the United States for thousands of years."

Window Glass Prices Reduced

Lower prices for flat window glass were announced by the American Window Glass Company on August 29 for carload buyers in Zones B, C, D, E and F, as follows:

B quality single strength, first bracket.....90 & 4%
B quality single strength, above brackets.....89 & 4%
B quality double strength, all brackets.....90%

For all A quality single strength and double strength the prices are two points higher than for B quality.

The above discounts are from the October 15, 1912, list, f. o. b. factory; freight equalized with Pittsburgh, Columbus, Kansas and such other points as we may deem necessary from time to time.

Boxing and fractional cuttings charges extra, as per circular of December 23, 1926.

These prices are guaranteed for each of the said qualities for shipment into any one of the above zones, against the company's own declines up to date of shipment, on orders accepted for shipment into that particular zone, except orders for shipment into Zone D and the portion of Zone E lying north of North Carolina, prices for which are not guaranteed.

Outside Frosted Lamps Not Abolished

Doubts in the lamp trade as to whether the manufacturers of Mazda lamps would continue to furnish outside frosted ball lamps were recently cleared away when, as reported in *Lighting Fixtures and Lighting*, the manufacturers assured G. P. Rogers, of the Artistic Lighting Equipment Association, that not only will their production of 25-watt G18½, G25 and 40-watt outside frosted ball lamps be continued but that they will be available through all sources of distribution. Shortly after the introduction of the inside frosted lamp and the reported retirement of the old-time lamp, the Artistic Lighting Equipment Association, through resolutions adopted at two conventions, urged the manufacturers not to discontinue the outside frosted line. The 15-watt G18 bulb is not considered essential by the lamp manufacturers, though it will be obtainable on direct orders to the manufacturers.

The Artistic Lighting Equipment Association has arranged to conduct a drive to increase its membership and develop the organization.

Reduces Price of Ultra-Violet Transmitting Glass

The Corning Glass Works, Corning, N. Y., recently announced a reduction in the price of their Corex ultra-violet transmitting glass. The reduction was from $5.00 to $3.00 per square foot, for cathedral finish. Standard sizes will be 10 x 12" with a possibility of furnishing limited quantities in sizes 12 x 20". Fully transparent or clear polished glass will be furnished in sizes up to 10 x 12" at $5.00 per square foot, f. o. b. Corning, 1% 15 days, package extra.

The company states that this glass shows transmitting values approaching closely that of fused quartz glass, and greatly superior to that of any other glass or glass substitute of which they have any knowledge. The Company has developed other clear glasses having less transmission than Corex, but states that it has never felt justified in offering them to the public.

Annual Meeting of American Ceramic Society

The 1928 annual meeting of the American Ceramic Society will be held at the Ambassador Hotel, Atlantic City, N. J., February 5 to 11, inclusive. The tentative general program outlined by the New Jersey local committee, of which D. Parry Forst is chairman, begins on Sunday, February 5, with registration of members and president's reception. Music and dancing will be accessible. On Monday, February 6, a general session will be held at 9:30 a. m., division meetings will take place in the afternoon and a dinner-dance and cabaret in the evening. On Tuesday there will be division meetings morning and afternoon and in the evening a water carnival. On Wednesday morning division meetings will be held and in the afternoon a general meeting, followed by a banquet at 7:30 p. m. The rest of the week, from Thursday to Saturday, will be spent on trips by divisions to plants in New Jersey, Pennsylvania and Maryland.

Samples of Advertising Novelties Wanted

The Osaka Municipal Office, M. Yashiba, Director, Department of Commerce and Industry, Osaka, Japan, wishes to notify glass and other manufacturers of advertising novelties in this country that an exhibition of such novelties will be held in Osaka, in the hope of interesting the general public and encouraging trade between the two countries. Osaka is the largest distributing and manufacturing center of Japan, with a population of 2,200,000. If senders of samples desire to have them returned after they have served their purpose, the Osaka Municipal Office offers to return them at its own expense. It is to be noted that only samples of novelties bearing advertising matter are desired.

Boosting Glass in Pittsburgh

A campaign to popularize the use of glass containers, similar to those successfully carried on recently in Indianapolis and Columbus, but on an even more aggressive basis, will be opened in Pittsburgh the week of October 10. The drive will continue for four weeks. Newspaper advertising, window displays, distribution of folders, pamphlets, etc., have been arranged for. Preliminary meetings of members of the association with field workers, representatives of packers and dealers and others, are being held.

On October 27 a big rally will be held by members of the association, who will visit stores making unusual window displays and demonstrations and consult dealers. The advertising will be a part of the national campaign recently authorized by the members of the association to defray the cost, of which over $200,000 is being contributed by association members.

The next similar demonstration, after the Pittsburgh campaign is over, will take place in New York and its suburbs.

Rossford, Ohio, Interests Get Bicheroux Process License

The statement in the leading article in this issue, to the effect that interests closely connected with the Edward Ford Plate Glass Company of Rossford, Toledo, Ohio, if not the Company itself, have acquired a license to use the patent rights and practice the patented Bicheroux process for making plate glass, came from a very responsible source, though it has not yet been officially affirmed or denied at Toledo.

Should the controlling interests decide to put the process into commercial operation in the near future, the trade will doubtless watch the outcome with the keenest attention, because of its potential significance to the entire flat glass industry.

Bottlers Convention in New Orleans

The annual exposition of the American Bottlers of Carbonated Beverages will be held in New Orleans, La., November 14 to 18. Included among the exhibitors will be a number of manufacturers of glass bottles They are: American Bottle Company, Toledo, O.; Chattanooga Bottle & Glass Manufacturing Company, Chattanooga, Tenn.; Cunningham Glass Company, Pittsburgh, Pa.; Graham Glass Company, Evansville, Ind.; Illinois Glass Company, Alton, Ill.; Laurens Glass Works, Laurens, S. C.; Pierce Glass Company, Buffalo, N. Y.; Root Glass Company, Terre Haute, Ind.; Southern States Bottle Company, Shreveport, La., and Three Rivers Glass Company, Three Rivers, Tex.

Secretary Purdy Abroad to Complete Tour Details

Members of the American Ceramic Society are being strongly urged to so arrange their affairs that there will be no hindrance to their taking the foreign ceramic tour planned for next May.

President B. Mifflin Hood has pointed out the advantages of going with the party and refers to the important fact that the privilege of visiting European factories will undoubtedly be more freely accorded by manufacturers to the ceramists as a party than it would as individuals.

Secretary Purdy and the tour manager, P. G. B. Morriss, are on their way to Europe to perfect the details of the tour for next summer.

Glass Container Association's New Booklet

A statement of the purposes and activities of the Glass Container Association of America has been issued in the form of a booklet. The organization and its departments are briefly described, including research, traffic, statistical, business and administration. *The Glass Container*, the official publication, is referred to, and standardization of finishes, tariff and legislative activities, governmental contacts, group activities, etc., are covered. Copies may be obtained from the association's office at 22 East 75th Street, New York.

Plate Glass Production in August

Figures compiled by P. A. Highes, secretary of the Plate Glass Manufacturers of America, show the production of polished plate glass for the month of August to have been 10,615,978 square feet. While this is nearly 2 million square feet more than the production for July, it does not equal the production for August, 1926, which was 11,274,084 square feet.

Refractories Meeting Postponed

The American Refractories Institute meeting, originally scheduled to take place at Niagara Falls, Ontario, on September 15, was cancelled after our last issue, announcing it, went to press. Notice has since been given by Dorothy A. Texter, secretary of the Institute, that the meeting will be combined with the winter meeting, which will be held in conjunction with the American Institute of Chemical Engineers at the Chase Hotel, St. Louis, Mo., on Tuesday, December 6.

Window Glass Investigation Progressing

The investigation into foreign production costs of window glass by the United States Tariff Commission is to be actively prosecuted by specialists who, according to a recent announcement of the Commission, will shortly visit Belgium to obtain information from the window glass manufacturers in that country. Meantime, the data gathered by the Commission's representatives in the domestic field is being tabulated and will be reported to the Commission later on. Sixteen American plants, representing 90% of the domestic production of window glass, were covered by the investigation.

Production of fire brick in the United States is given in the 1925 Census Report on the Clay Products Industries, recently issued, as 990,113,000 (9" equiv.) valued at $40,727,578. Silica brick to the amount of 235,877,000, valued at $11,280,127 were produced during the same year. Copies of this report may be obtained at 5 cents each from the Superintendent of Documents, Government Printing Office, Washington, D. C.

The Department of Commerce Monthly Summary of Imports and Exports of Glass will be found tabulated on the last text page of this issue.

Trade Activities

The Roanoke Glass Company, Roanoke, Va., is making additions to its mirror grinding and polishing department. M. P. Watkins is treasurer and manager.

The West Penn Mirror & Glass Company, New Kensington, Pa., has filed an application in the State of Pennsylvania for a charter, the object of the company being to purchase glass, fabricate the same, make and sell mirrors, glass and glass products.

Pine Glass Company, Okmulgee, Okla., is reported to have let the contract for a steel and concrete plant to cost approximately $80,000. Plans for the plant are said to have been prepared by the Walsh Fire Clay Products Company, St. Louis, Mo.

The Harrison Glass Company, which was recently organized by H. D. Stone, J. Van Koonse and W. H. Tomlinson of Cameron, W. Va., and which has taken over the plant known as the Alley Glass Company of Salem, W. Va., are preparing to start manufacturing perfume and toilet bottles.

Greiner Glass Manufacturing Company, Inc., have moved from the temporary factory at 1603 Metropolitan Avenue, Brooklyn, N. Y., to their new plant on Clara Place, in the same city, which replaces the one lost by fire last December. The company manufactures and stocks all sizes and varieties of glass rods.

Ball Brothers Glass Company, according to local reports, will soon reopen the old Charles Boldt glass plant at Huntington, W. Va. A bridge leading to the glass plant which was in dangerous condition and which was reported to have been the cause of the shutdown several weeks ago, has been repaired.

The Mathieson Alkali Works, Inc., 250 Park Avenue, New York, announced the appointment on September 1 of H. D. Honan, formerly connected with the Philadelphia district sales office, as sales manager of the St. Louis district, replacing F. H. Lovenberg, who has been assigned to the New England district sales office, Providence, R. I.

Edward Miller, proprietor of the Miller Machine & Mold Works, manufacturers of glass house machinery, 705-719 Ann Street, Columbus, O., is in Los Angeles, Cal., supervising the installation of a milk bottle machine sold to the West Coast Glass Company. Mr. Miller intends to visit every glass manufacturer on the coast while on this trip.

Landon P. Smith, Inc., Irvington, N. J., manufacturers of the well known "Red Devil" glass cutter and other glaziers' supplies, is reported to have acquired a half interest in the Hubbard Company, Windsor, Vt., manufacturers of glass cutting machinery. Mr. Smith and D. G. Smith will direct the management of both corporations. Improvements at the Windsor plant are contemplated.

The Wellman-Seaver-Morgan Company, Cleveland, O., announce the incorporation of an associated company in Canada, known as the "Canadian Wellman-Seaver-Morgan Company, Limited," under the Dominion Companies Act, with head office at 307 Reford Building, Toronto, Canada, and branch office at 808 Drummond Building, Montreal, for the handling of the well-known line of this company's products, which include gas producers, coal and ore handling machinery, mining machinery, special cranes, port and terminal equipment, steel works equipment, coke oven machinery, and other specialties.

The Illinois Glass Company's plant at Gas City, Ind., resumed operations at full capacity about the middle of September. All four furnaces, including a new one, have been put in operation and at the present time the plant is operating with a force of 550 men. Included among the new improvements which have been made to the plant during the past year are a new power house capable of generating 2,000 h.p., a new building for the manufacture of corrugated paper and also modern equipment for producing semi-wide mouth and narrow neck bottles. Further improvements are contemplated in the near future. E. M. Greenwood is plant superintendent.

The C. A. Borchert Company, Weston, W. Va., glass cutters and decorators, formerly owned by several citizens of Cumberland, Md., has been purchased by four men of Weston for approximately $20,000. The new owners and the offices they will occupy are as follows: C. A. Borchert, president and general manager; Andrew Edmiston, vice-president; Kenneth S. Kurtz, treasurer, and Frank H. Shaffer, secretary. Local reports stated that the company was contemplating the installation of new equipment but the company states that no improvements are being made at present. The plant is running full capacity. The products of the Louie Glass Company, also of Weston, are employed in the concern's cutting and decorating business.

Industrial Publications

Recording Ammeters. Catalog 1502, Ammeter Section. The Bristol Company, Waterbury, Conn. A 28-page pamphlet illustrating and describing various types of ammeters.

Worm Gears and Drives. Bulletin E, Fawcus Machine Company, Pittsburgh, Pa. 32 pages of description, data and illustrations on Fawcus worm gears and drives, of which a large part consists of engineering data.

Morris Runways. A 24-page booklet issued by Herbert Morris Incorporated, Buffalo, N. Y., on Morris overhead runways. This company also manufactures air hoists, chainblocks, trolleys, jib cranes, traveling cranes, etc.

Caldwell Tanks and Towers in Wood and Steel. W. E. Caldwell Company, Inc., Louisville, Ky., has issued the 37th annual edition of their catalog of tanks and towers suitable for factories and other organizations. Many kinds are listed and illustrated.

Illumination Terms. Bulletin LD155. Information compiled by the engineering department of the Edison Lamp Works of the General Electric Company, Harrison, N. J. This is a 56-page booklet containing definitions of hundreds of terms used in the illuminating industry relating to light, lighting and lighting equipment.

The Testing of Washing Solutions. An eight-page paper-covered educational bulletin, No. 1, issued by Junior Owens, secretary of the American Bottlers of Carbonated Beverages, 726 Bond Building, Washington, D. C. The subject of the bulletin is the testing of washing solutions for bottles. The authors of the article are G. H. Buchanan and Max Levine, of the A. B. C. B. research fellowship. Copies of the bulletin may be obtained from the secretary at 10 cents each.

"Commerce Reports" states that the Belgium glass industry continues to show slight improvements on the whole. One firm has now entered the field with a type of opal glass and a new firm is reported to have started the production of glass for many purposes. Organization control is said to be working out successfully and a transformation from hand manufacture to machine methods in some branches of the industry continues.

Mechanical Drive Turbines. GEA-578A, General Electric Company, Schenectady, N. Y. An eight-page loose leaf insert devoted to Type D mechanical drive steam turbines which have been found very satisfactory in the operation of centrifugal pumps and other apparatus. These turbines are available in capacities of 5 to 700 horse power at speeds from 1000 to 5000 r. p. m. and can be arranged for all ordinary steam conditions.

Automatic Combustion Control. Bulletin No. 660, Leeds & Northrup Company, Philadelphia, Pa. An automatic system of metered combustion control for boiler furnaces. An electrical current controlled by a steam pressure and flow in the steam main cooperates with air or gas flow meters, furnace pressure meters, and stoker or fuel feeder meters, to regulate stokers, fuel feeds, fans and dampers as required to preserve constant steam pressure, to secure the desired division of load among boilers, to insure the most favorable furnace percentage of excess air or CO_2 and to hold the most favorable furnace pressure.

Personals

A. Solomon, the well known head of L. Solomon & Son, New York, importers of plate and window glass, and his family returned early in September from their vacation abroad.

Professor Alexander Silverman, Head of the Department of Chemistry, University of Pittsburgh, gave an illustrated lecture on "Glass" before the Akron Section of the American Chemical Society, Thursday, September 29.

Meyer Eppstein, for the past nine years factory superintendent of the Charleston, W. Va., plant of the Owens Bottle Company and connected with that company for over twenty years, has been made plant manager to succeed W. E. Plummer, who will be located on the Pacific Coast.

Recent Deaths

Charles B. Sligh

Charles B. Sligh, aged 77, of the Sligh Furniture Company, Grand Rapids, Mich., and an important witness at the plate glass tariff hearing held by the United States Tariff Commission in Washington early in May, died from heart disease on Thursday, September 15 on the *"S.S. Berengaria"* while en route to the United States. Mr. Sligh had been threatened with pneumonia while traveling in Switzerland and had cut his vacation short to hurry home.

Coming Meetings

The American Ceramic Society annual meeting will be held at the Ambassador Hotel, Atlantic City, N. J., February 5, 1928. European tour of Society will cover a period of six weeks beginning May 19, 1928, and will include visits to England, Germany, Czechoslovakia, France, Holland.

The First National Fuels Meeting of the Fuels Division of the American Society of Mechanical Engineers will be held in St. Louis, Mo., October 10 to 13 inclusive.

The Glass Container Association will hold its fall meeting at the Fort Pitt Hotel, Pittsburgh, Pa., October 27 and 28.

The American Bottlers of Carbonated Beverages will hold is annual exposition at New Orleans, La., November 14 to 18.

The Eastern Glass Distributors Association will hold its next meeting in New York City on November 10.

What the World Wants

Specific Inquiries for American Goods, Received in the Department of Commerce, Washington, D. C.

Cuba: 26986, glass and earthenware.
India: 26996, glass and porcelain ware.
Canada: 27287, pint and quart milk bottles; 27229, glassware, glass bottles and jars.
South Africa: 27238, cut and pressed glassware.
England: 27238, glassware and glass bottles and jars.

Glass Stock Quotations

PITTSBURGH STOCK EXCHANGE, SEPTEMBER 23, 1927

Reported by Moore, Leonard & Lynch, Union Trust Bldg., Pittsburgh, Pa.

	Bid	Asked	Last
American Window Glass Machine, com...	..	35	35
American Window Glass Machine, pfd...	..	70	69½
American Window Glass, pfd.....	..	..	105
United States Glass.....	11	13½	11
Pittsburgh Plate Glass, com.....	..	..	228
Standard Plate Glass, com.....	..	..	3⅜
Standard Plate Glass:			
Preferred cumulative	15	..	14½
Prior preferred	25	..	33

TOLEDO, O., SEPTEMBER 21, 1927

	Bid	Asked	Last
Owens Bottle, pfd.	..	..	119½
Libbey-Owens Sheet Glass, com.	..	..	128
Libbey-Owens Sheet Glass, pfd.	..	..	115

WHEELING STOCK EXCHANGE, SEPT. 24, 1927

	Bid	Asked	Last
Hazel-Atlas	70	70½	70½
Imperial	..	..	72
Fostoria	200	..	208
Central	..	..	75

READERS WANTS AND OFFERS

For Sale—Fifteen high grade photographic lenses, made by Delmeyer, Swift, Ross and Zeiss. Price very reasonable. Address: Lenses, care The GLASS INDUSTRY, 50 Church Street, New York.

Wanted: Chemist to take charge of mixing and melting glass. Capable of producing first class flint. Give experience, salary wanted and when ready to start. Address K-1, care The GLASS INDUSTRY, 50 Church Street, New York.

For Sale: CULLET of all Descriptions
Free from Caps, Wires, etc.
GEORGE F. BAUMANN, Dealer,
1110 Carroll Street, Brooklyn, New York.
Carloads Ready for Immediate Shipment.

For Sale: Journal of the Society of Glass Technology. December, 1919; March and December, 1923. Complete sets of 1920, 1921 and 1922. Price (unbound) $22.00. Address Box P, care THE GLASS INDUSTRY, 50 Church Street, New York.

Current Prices of Glass-Making Materials

September 23, 1927

Quotations furnished by various producers, manufacturers and dealers.

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	.44½	.44½
Hydrochloric (HCl) 20° tanks, per 100 lb.		..	1.05-1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	5.75
Sulphuric (H_2SO_4) 66° tank cars	ton	15.00-16.00	..
Tartaric	lb.	.37	.39½
Alcohol, denatured	gal.	..	.46
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05-.05½
Aluminum oxide (Al_2O_3)	lb	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.19-.21
Ammonia water (NH_4OH) 26° drums	lb.	.02½	.02¾
Antimony, metallic (Sb)	lb.	..	.10⅝-.10¾
Antimony oxide (Sb_2O_3)	lb.	..	.14½-.16
Antimony sulphide (Sb_2S_3)	lb.	.15	.16
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04¼-.04½
Barium carbonate ($BaCO_3$)			
Precipitated	ton	53.00	58.00
Natural, powdered, imported	ton	48.00	50.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08¼	.08½
Barium selenite ($BaSeO_3$)	lb.	..	..
Bone ash	lb.	.05	.05½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	.03¾	.04-.04½
Boric acid (H_3BO_3)	lb.	..	.08¼-.08½
Refined	lb.	.08-.08¼	.08½-.08¾
Cadmium sulphide (CdS)—			
Red	lb.	..	1.20
Orange	lb.	..	1.10-1.25
Yellow	lb.	..	1.20-1.40
Chromium oxide (Cr_2O_3)	lb.	.27	.28
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.30
Black (CuO)	lb.	..	.25-.30
Black prepared	lb.	.	.30
Cryolite ($Na_3Al\ F_6$) Natural Greenland Kryolith)	lb.	..	.09½-.09½
Artificial or Chemical	lb.	..	.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.30
Feldspar—			
100 mesh	ton	11.00-20.00	15.50-22.00
80 mesh	ton	..	14.50
40 mesh	ton	12.50	13.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2, 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Formaldehyde	lb.	.08½-.09½	.10
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.02-.03½
Black (FeO)	lb.	..	..
Kaolin (f.o.b. mine)	ton	10.00	..
English, lump, f.o.b. New York	ton	13.00-23.00	..
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	..	..
Lead oxide (Pb_3O_4) (red lead)	lb.	.09¾	.09¾-.10
Litharge (PbO)	lb.	.08¾	.08¾-.09
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	12.50	..
Burnt (CaO) ground, in bulk	ton	9.00	..
Burnt, ground, in paper sacks	ton	11.00	..
Burnt, ground, in 280 lb. bbls. Per bbl.		2.15	2.30
Limestone ($CaCO_3$)		2.00	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.05-.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07½-.08
Manganese 85% (MnO_2)	lb.	.04½	.05
Nickel oxide (Ni_2O_3), black—			
for nickel content	lb.	..	.35
Nickel monoxide (NiO), green—			
for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	..	23.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.08¼	.08½
Ground	lb.	.11	.12
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.06⅝	.07⅛
Hydrated 80-85%	lb.	.06	.06½
Potassium chromate (K_2CrO_4)	lb.	..	.27
Potassium hydrate (KOH) (caustic potash)	lb.	.07½	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.05⅞-.06
Potassium permanganate ($KMnO_4$)	lb.	.14½	.15
Powdered blue	lb.	..	.24-.26
Rochelle salts, bbls.	lb.	..	.23
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	2.10-2.15
Silver nitrate ($AgNO_3$)	oz.	...	.40¼
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.22½-1.27½	..
In barrels	Per 100 lb.	1.55-1.57½	2.40
In bags	Per 100 lb.	1.37½	..
Spot orders .05 per 100 lbs. higher			
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¼	.06⅝
Sodium hydrate (NaOH) (caustic soda)	Per 100 lb.	..	3.50
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03¾	.04
95 per cent.	Per 100 lb.	2.35	2.80
Sodium selenite (Na_2SeO_3)	lb.	..	2.35
Sodium fluosilicate (Na_2SiF_6)	lb.	.04½-.05	.05-.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.25
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.45	3.80-4.00
Flowers, in bags	Per 100 lb.	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.44	.44½
Tin oxide (SnO_2) in bbls.	lb.	.66	.67
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots	lb.	..	1.25-2.25
Zinc oxide (ZnO)	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to August 24, 1927

	July 1926 Quantity	July 1926 Value	July 1927 Quantity	July 1927 Value	Seven Months Ending July 1926 Quantity	Seven Months Ending July 1926 Value	Seven Months Ending July 1927 Quantity	Seven Months Ending July 1927 Value
Glass and glass products (total)	.....	$743,028	.....	$750,044	.....	$5,178,647	.....	$5,178,910
Plate and window glass—								
Window glass, common, box 50 sq. ft.	2,043	13,198	3,427	11,416	19,476	109,601	13,747	74,784
Plate glass, unsilvered, sq. ft.	8,555	6,415	41,956	20,549	695,194	172,562	549,210	180,874
Other window and plate glass lbs.	169,695	19,277	296,678	32,203	1,352,459	134,862	2,697,251	262,499
Glass containers (bottles, vials and jars)	.....	302,745	.....	280,607	.....	1,698,542	.....	1,789,242
Table glassware, plain	.....	139,121	.....	103,733	.....	956,998	.....	852,240
Table and other glassware, cut or engraved	.....	12,890	.....	8,468	.....	106,853	.....	77,730
Lamp chimneys and lantern globes lbs.	163,733	31,372	155,733	29,077	1,332,010	248,281	1,219,286	248,859
Globes and shades for lighting fixtures lbs.	130,531	45,545	163,508	57,078	1,009,693	324,711	1,017,630	370,321
Chemical glassware lbs.	18,659	17,178	29,558	21,138	127,928	117,717	117,269	107,306
Electrical glassware, except for lighting lbs.	307,413	28,901	281,425	29,647	3,543,264	307,463	1,482,182	143,592
Other glassware	.....	126,386	.....	156,128	.....	1,001,057	.....	1,071,463

IMPORTS

Corrected to August 24, 1927

Glass and glass products	.....	1,688,533	.....	1,312,993	.....	11,933,768	.....	9,576,461
Cylinder, crown and sheet—								
Unpolished dut. lb.	7,291,540	225,475	.....	.....	47,273,294	1,975,450	.....	.....
Weighing less than 80 pounds per case dut. lb.	.....	.....	4,494,516	106,503	.....	.....	29,041,186	747,666
Weighing 80 pounds or over per case dut. lb.	.....	.....	2,694,305	93,439	.....	.....	25,020,018	1,083,186
Bent, ground, beveled, colored, painted, etc., and polished dut.	.....	49,196	.....	15,646	.....	348,246	.....	220,620
Plate glass dut. sq. ft.	2,181,965	701,233	.....	.....	16,156,015	5,293,707	.....	.....
Polished, unsilvered dut. sq. ft.	.....	.....	1,038,758	269,471	.....	.....	9,869,869	2,875,081
Other dut. sq. ft.	.....	.....	70,010	18,664	.....	.....	668,847	161,977
Bottles, vials, jars, demijohns and carboys, molded or pressed dut.	.....	19,486	.....	13,102	.....	167,844	.....	111,436
Table and kitchen utensils dut.	.....	8,765	.....	8,641	.....	45,041	.....	66,575
Glassware, cut or decorated dut.	.....	240,718	.....	306,779	.....	1,427,577	.....	1,948,397
Blown glassware, n. e. s.—								
Bottles, ornaments, gauge glasses and other n. e. s. dut.	.....	201,816	.....	250,321	.....	803,285	.....	658,792
Bulbs for electric lamps dut. No.	1,305,177	11,158	950,625	9,764	11,315,684	127,036	8,396,301	79,468
Chimneys, globes, shades, prisms and other illuminating glassware dut.	.....	77,086	.....	68,096	.....	601,760	.....	497,857
Articles and utensils for chemical, scientific, and experimental purposes dut.	.....	44,729	.....	38,956	.....	335,991	.....	307,844
Other glassware dut.	.....	108,871	.....	113,611	.....	807,831	.....	817,562